ERRATA

Part Two - Chapter XXIX - Special Subjects Subregion "C"

Pg. I-7, Par. 9, Line 6; change 32.5 to 35.

Pg. I-29, Line 1; change form to firm.

Pg. III-20, Par. 39, Line 3; change Plate 16 to Plate 10.

Pg. III-53, Line 2; change $982,138 to $988,138.

Pg. III-59, Par. 133, Line 5; change all to call.

Pg. III-63, Line 6; change traffic of to traffic, or.

Pg. III-69, Par. 160, Line 2; change southeasterly to southwesterly.

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
150 CAUSEWAY STREET
BOSTON 14, MASSACHUSETTS

Final revisions
Special Subjects Subregion "C"
Chapter XXIX - Part Two
March 11, 1955

1. Attached are revised pages iii, iv, I-1, I-2, I-3, and III-47. In addition there is attached Section IV with 31 pages. The revised pages, including Section IV, comprise the final revision for Part Two, Chapter XXIX of the Report of the New England-New York Inter-Agency Committee entitled The Resources of the New England-New York Region, Special Subjects Subregion "C". Note that each revised page is identified by the revision symbol in the lower corner. It is requested that you open the binding of your copy, remove the superseded pages, insert the revised pages and destroy the replaced pages.

2. Also attached is an errata sheet showing minor corrections for which no revised pages are furnished. It is requested that you make all the changes indicated on the errata sheet.

3. Upon completion of the above, the copy of this chapter of the Report which you have will be in final form.

G. B. Troland

G. B. TROLAND
Coordinator

FOREWORD

This book contains one chapter of Part Two of the Report of the New England-New York Inter-Agency Committee, organized by direction of the President of the United States for the purpose of making a comprehensive survey of the land, water and related resources of the New England-New York Region.

The complete report comprises three parts:

Part One - The General Report.

Part Two - The Technical Report, with detailed studies of the river basins and special subjects.

Part Three - Reference Data.

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OF THE

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THE RESOURCES

OF THE

NEW ENGLAND - NEW YORK REGION

PART TWO

CHAPTER XXIX

SPECIAL SUBJECTS
SUBREGION "C"

VERMONT - NEW YORK

NEW ENGLAND NEW YORK INTER - AGENCY COMMITTEE

SPECIAL SUBJECTS SUBREGION "C"

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DESCRIPTION OF AREA

1. Great Lakes. - The St. Lawrence River is the outlet of the Great Lakes system, which is shown on Plate 1. Lake Superior, uppermost and largest of the lakes, discharges through St. Mary's River into Lake Huron. Lake Michigan connects with Lake Huron through the Straits of Mackinac, a channel of sufficient width and depth to keep both lakes at the same level. Lake Huron discharges through St. Clair River, Lake St. Clair, and the Detroit River to Lake Erie, which discharges through Niagara River to Lake Ontario, the source of the St. Lawrence. There is a fall of 23 feet from Lake Superior to Lake Huron, of 8 feet from Lake Huron to Lake Erie, and of 326 feet from Lake Erie to Lake Ontario, of which 167 feet occurs at Niagara Falls.

2. St. Lawrence River. - The river flows northeast 533 miles from Tibbetts Point on Lake Ontario to Father Point at the head of the Gulf of St. Lawrence. The upper river is a series of relatively quiet reaches separated by rapids. From Tibbetts Point to Chimney Point, 68 miles, the river is deep and relatively slow, with numerous islands, and falls approximately one foot. This reach is called the Thousand Islands section. In the 47 miles from Chimney Point to the head of Lake St. Francis, there is a fall of 92 feet. This reach is known as the International Rapids Section. Downstream from the International Rapids Section, which is near the point where

Table 1 - Falls and reaches of the St. Lawrence River Subregion "C"

Section of river	Length (miles)	Fall (feet)
1. Thousand Islands section Tibbetts Point to Chimney Point	68	1.15
2. International Rapids section Chimney Point to head of Lake St. Francis	47	92.
3. Lake St. Francis section Head to foot of Lake St. Francis	26	1.
4. Soulanges section Foot of Lake St. Francis to head of Lake St. Louis	18	82.8
5. Lachine section Head of Lake St. Louis to Montreal Harbor	24	48.75
6. Montreal Harbor to sea level		20.

the south bank becomes Canadian, the river expands into Lake St. Francis, 26 miles long. In 18 miles downstream from Lake St. Francis, the river falls about 83 feet through the Soulanges Rapids. These rapids are followed by the 10-mile long Lake St. Louis, from which there is a fall of 49 feet, through the Lachine Rapids and other shoals with a total length of 14 miles, to Montreal Harbor. Below Montreal, the river falls 20 feet to sea level and varies considerably in width from reach to reach, but the current is negligible. The total drainage area above Chimney Point is 298,090 square miles, of which the water surfaces of the Great Lakes total 95,170 square miles. The storage in the lakes provides a high degree of flow regulation. The average discharge at Ogdensburg,

New York from June 1860 to March 1953 was 240,000 cubic feet per second, with monthly means varying from 317,000 to 152,000 cubic feet per second.

GEOLOGY

3. General. - The St. Lawrence Valley is a region of low relief which has been modified considerably by glaciation and invasion by the sea. The valley is within the St. Lawrence plain which stretches between the Adirondack Mountain highland of New York and the Canadian highland in Ontario and Quebec. From Lake Ontario to near Brockville, the underlying bedrock consists of Pre-Cambrian crystalline formations which constitute a narrow connection between the large areas of similar rock in the two highlands. Downstream from the easterly edge of this connecting belt, the St. Lawrence plain varies from 60 to 70 miles in width and is underlain by flat-lying early Paleozoic sedimentary rocks. Few lakes are found in the valley, but there are many swamps and marshes in the wide, flat lowlands.

4. Surficial geology. - The bedrock in most of the region is covered by compact till or hardpan, a heterogeneous unstratified material composed of clayey to silty, gravelly sand with scattered boulders. This till formed at the bottom of the ice sheet during the most recent, Pleistocene glacial period. The ice sheet apparently advanced over the area from the northwest and plowed up the soil and loose rock which had accumulated as a result of weathering. It is probable that some of the

material picked up was incorporated into the main mass of ice and, when the ice finally melted, was deposited on the underlying hardpan and formed deposits of looser, more sandy upper till. The land was apparently depressed below sea level by the weight of the ice-sheet, and, as the ice melted, sea-water occupied the St. Lawrence Valley. Wave and current action cut into the ridges left by glacial action and, with material brought in by streams from the highlands, modified and subdued the irregular topography, filling the deeper valleys beneath marine silt and clay. Wide sand plains such as those near Waddington, New York were formed by deposits in shallow water as the land rose. The present topography of the valley is essentially the same as when it emerged from the sea, except that a haphazard drainage system has developed. The drainage is largely drift-controlled and streams have encountered rock in only few places, forming rapids, as at Galop and Long Sault, in the St. Lawrence River.

5. Bedrock. - The bedrock of the valley downstream from Brockville, New York is a series of early Paleozoic sedimentary rocks overlaying the Grenville and other pre-Cambrian crystalline rocks. The only formations exposed under the river between Ogdensburg and Valleyfield are the Beekmantown and Chazy formations of Ordovician age. The area is covered with a thick blanket of drift, so that rock exposures are uncommon and the

tracing of exact formation boundaries is practically impossible. The Beekmantown formation consists of dolomite with occasional thick strata of sand stone, limestone, and shale. The Chazy formation is more variable and consists of dolomite interbedded with numerous strata of shale, limestone and sandstone. Small deposits of gypsum occur in the upper Beekmantown and lower Chazy formations. The strike of the formations trends northeast-southwest in the vicinity of the river and the dip to the northwest is very gentle. Weathered rock in the area appears to have been removed by ice so the present bedrock is fresh, hard and solid. The rock is cut by joints which intersect the almost horizontal bedding planes at various angles.

6. Faulting. - A few faults are known to occur in the International Rapids area, and appear to be part of a large system of similar faults mapped throughout the surrounding area. This area has undergone progressive uplift since post-glacial times and there is evidence that uplift is still occurring. Earthquakes of feeble or mild intensity are common in the St. Lawrence plain, but are infrequent in the adjoining regions. The recorded seismic disturbances upstream from Montreal have varied from slight vibrations to shocks of moderate intensity, while more intense shocks have occurred in the valley downstream from that city. While no earthquakes of destructive magnitude have been recorded in the

vicinity of this project during historic times, the possibility of future movement along these old fault planes cannot be disregarded and this possibility has been considered in the studies.

7. International Rapids section. - Within the International Rapids section, the geologic formation, in general, consists of glacial till ranging in thickness from a few feet to over 200 feet, including thick beds of marine clay in many localities. These formations overlie the bedrock which is generally uniform in contour but broken by gentle valleys and ridges, with a general north-south strike, which are in turn intersected by depressions from pre-glacial drainage channels. The glacial till is an irregular mixture of clay, sand, gravel, and boulders. The bed and banks of the stream are in general paved with large boulders and are not subject to erosion. This condition, together with the great storage capacity of the Great Lakes, renders the river water unusually free from silt. The winter climate is severe and heavy ice forms wherever flow conditions permit. The ice problem is an important factor in the design of hydraulic structures.

8. Economy of the Great Lakes area. - The drainage area tributary to the Great Lakes consists of a comparatively narrow belt of land extending around the lakes and including practically all of the two peninsulas of Michigan. The United States portion of the region is generally well developed industrially and agriculturally and includes the cities of Buffalo, Erie, Cleveland,

Toledo, Detroit, Chicago, Milwaukee, and Duluth, and many other smaller cities. On the Canadian side north of Lake Superior is a rather barren, glaciated region with bedrock exposed in many areas, where the only developments are scattered mines. The Canadian territory tributary to Lakes St. Clair, Erie, and Ontario is well developed agriculturally with many important industrial centers including Toronto, Hamilton, and Windsor. Except for the area north of Lake Superior, the region is well supplied with highways, railroads, and airlines.

9. Navigation facilities on the Great Lakes. - The St. Lawrence River system, in conjunction with the Gulf of St. Lawrence, provides a continuous waterway extending 2,347 miles from the Atlantic Ocean to Duluth, Minnesota. The first 843 miles, from the ocean to the City of Quebec is through the Gulf of St. Lawrence and a tidal estuary with depths of over 35 feet. A depth of ~~32.5~~ 35 feet is maintained between Quebec and Montreal. From Quebec to Lake Ontario, approximately 342 river miles, the channel of the St. Lawrence River is subdivided by many islands and the slope broken by numerous rapids which, under original conditions, were severe barriers to navigation. From the foot of Lake Ontario, through the Great Lakes and their connecting channels, the sailing distance is 1,162 miles to Duluth, Minnesota and 1,061 miles to Chicago, Illinois. Generally speaking, the main bodies of the lakes have ample depths for all classes of navigation, but the connecting waterways in their original

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condition presented barriers to the passage of vessels. The connecting channels are: Niagara River, containing Niagara Falls and Whirlpool Rapids, between Lakes Ontario and Erie (Welland Canal used for navigation); Detroit River, Lake St. Clair, and St. Clair River between Lakes Erie and Huron; St. Mary's River (with locks) between Lakes Huron and Superior; and the Straits of Mackinac (of ample depth) between Lakes Huron and Michigan. Commercial navigation facilities are important; the waterway between Lakes Superior and Huron and Lakes Huron and Erie carry many times more tonnage than any other inland waterway in the world. The freight passing the locks at Sault St. Marie in 1953 was 128,500,000 tons. The waterborne commerce consists principally of iron ore, coal, and grain and is carried in a large fleet of vessels especially designed for local conditions. Navigation between the ocean and lake ports is limited to vessels suited to the limited dimensions available in 6 canals around rapids in the St. Lawrence River between Montreal and Ogdensburg, the locks of which have controlling dimensions of 252 feet in length, 44 feet in width, and depth of 14 feet over sills. The limiting vertical clearance of high-level fixed bridges over St. Lawrence River is 150 feet, and, under vertical lift bridges over the Welland Canal is 120 feet; the width of channels through bridges exceeds the limiting widths in locks. In the connecting rivers and ship channels which govern navigation on the Great Lakes above Ogdensburg,

the available depth is at least 21 feet for up-bound traffic and 24.8 feet for down-bound traffic. A survey review report is now in preparation which is considering providing depths of at least 27 feet from Lake Erie to Lake Superior. The only canal navigation is in the Welland Ship Canal, with a depth of 25 feet, between Lakes Ontario and Erie with locks having a usable length of 765 feet, a width of 80 feet and a depth of 30 feet, and in St. Mary's River near Lake Superior with locks having usable length of 1,300 feet and width of 80 feet. Commerce in 1952 in the St. Lawrence River above Ogdensburg was 11,502,000 tons, and through the canals below Ogdensburg was 9,836,000 tons.

HISTORY OF PROJECT

10. General. - The St. Lawrence River system, including the Great Lakes, has been an important transportation route since it was first discovered and numerous attempts to improve navigation have been made by private interests and by Federal, Provincial, and State agencies. The first canal was built at Soulanges Rapids in 1779 and improvement and enlargement have been continuous. In 1895, the United States Deep Waterways Commission was established and instructed to confer with a similar organization set up by Canada for the purpose of studying the entire question of providing a deep water route from the Great Lakes to tidewater. In 1897, the Commission

submitted a report (House Document No. 192, 54th Congress, 2nd Session) which discussed various possible routes and recommended that a definite survey be made and reliable cost estimates be prepared. A Board of Engineers, appointed in response to this recommendation, submitted a report in 1900 recommending a 21-foot waterway across the State of New York connecting with the Hudson River (House Document No. 149, 56th Congress, 2nd Session). The report included a study of the improvement of the International Rapids Section of the St. Lawrence for navigation only, without power development.

11. International Joint Commission - 1909. A treaty between the two countries, signed January 11, 1909, created a permanent International Joint Commission, composed of members from both countries, to have jurisdiction over all matters pertaining to the boundary waters between the United States and Canada. In 1919, Congress expressed a desire for investigation by the International Joint Commission of the question of improving the St. Lawrence between Lake Ontario and Montreal. The following year, both Governments referred the question to the Commission and designated a joint engineering board consisting of Colonel W. P. Wooten, Corps of Engineers, and W. A. Bowden, Chief Engineer of the Canadian Department of Railways and Canals, to work with the Commission and provide the necessary expert

engineering assistance.

12. Wooten - Bowden Report - 1921. - The Wooten-Bowden Board submitted its report to the International Joint Commission June 24, 1921 and it was published as Senate Document No. 179, 67th Congress, 2nd Session. The report contained the following principal conclusions and recommendations:

a. Improvements for navigation between Montreal and Lake Ontario of permanent character and with low upkeep cost could be installed, but improvement for navigation alone was not recommended because of the great loss which would result from failure to develop approximately 4,100,000 horsepower of potential hydroelectric power.

b. Development of this quantity of power was not justified because of lack of market and only a part should be developed at the time.

c. A sound procedure would be development of the International Rapids Section for both navigation and power, providing a 25-foot navigation channel with 30-foot depths over lock sills; and development of the other sections for navigation only, postponing power development until needed.

d. The estimated cost of the work would be:

1.	Montreal Harbor to Lake St. Louis (Navigation only)	$55,783,000
2.	Lake St. Louis to Lake St. Francis (Navigation only)	36,590,000

3.	Dredging in Lake St. Francis	1,158,000
4.	International Rapids (St. Regis to Chimney Point) (navigation and 1,380,000 kilowatts power development)	159,097,000
5.	Dredging from Chimney Point to Lake Ontario	100,000
	Total	$252,728,000

e. The additional cost of providing a navigation depth of 30 feet throughout would be $17,986,000.

13. The Wooten-Bowden plan contemplated the creation of head of 74 feet at the powerhouses by construction of a dam across the river at the downstream end of Long Sault Island, with a control dam located in the vicinity of Ogden Island to regulate the outflow from Lake Ontario and to improve navigation between that dam and Chimney Point. There would be no power installation at the control dam. The main dam and related structures would be designed so that, at a future date, their height could be increased to utilize the full available head.

14. International Joint Commission report - 1921. - The Commission held public hearings and several alternate plans were presented. The Commission, on December 19,1921, submitted its report which was transmitted to Congress by the President January 16, 1922 (Senate Document No. 114, 67th Congress, 2nd Session). The report contained two principal recommendations:

a. That the two Governments enter into an agreement by way of a treaty for the improvement of the St. Lawrence River between Montreal and Lake Ontario, based upon the Wooten-Bowden report, with the understanding that, before any final decisions are reached, the report of that board, together with the alternate plans presented during the public hearings, would be given further consideration by an enlarged engineering board.

b. That the new Welland Ship Canal be embodied in the scheme and treated as a part thereof.

15. Joint Board of Engineers Report - 1926. - In the spring of 1924, a new St. Lawrence Commission was set up, consisting of nine members from each country. In response to the International Joint Commission recommendation of 1921, a Joint Board of Engineers, consisting of three members from each country, was established to act with the new Commission in studying all phases of the problem. The necessary funds were provided by each country and, through an exchange of notes in February and March 1925, a set of instructions for the Board was agreed upon and issued. The Joint Board of Engineers held its first meeting in April 1925, and agreed upon a division of work between the two sections of the Board. The entire Board held frequent meetings and on November 16,1926 submitted through the St. Lawrence River Commission its report which is contained in Senate Document No. 183, 69th Congress, 2nd Session. The Board failed to agree on a plan for complete development of the

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International Rapids section and instead submitted two recommendations. The United States members recommended a so-called Single Stage Plan, estimated at $235,000,000, the principal features of which were: a main dam with two powerhouses (total installation 2,326,000 horsepower) located at the downstream end of Barnhart Island with the main channel south of the island as a forebay; a 27-foot channel for navigation following the channel south of Cornwall Island to the mouth of Grass River, thence through a canal containing two locks, and reentering the river at the upstream end of Barnhart Island; and closure of the South Galop Channel with a dam containing gates for regulation of flow, and an uncontrolled channel through Galop Island for navigation. The Canadian members recommended what was known as a Two Stage Plan, estimated at $264,600,000, the principal features of which were: a main dam at the head of Barnhart Island; two powerhouses (1,808,600 horsepower installed capacity) located at the downstream end of Barnhart Island with the channels north of the island as a forebay; a 27-foot channel for navigation following the channel south of Cornwall Island to the mouth of Grass River, thence through a canal containing two locks and reentering the river near the middle of Long Sault Island; a second dam with two powerhouses located at Ogden Island (300,000 installed horsepower on the Canadian side and 105,600 horsepower on the United States side); a navigation lock at Ogden Island; a hydraulic channel through Galop Island with gates for controlling the

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flow; and an uncontrolled channel south of Galop Island for navigation. An alternate plan, known as the Crysler Island Two Stage Plan, with an estimated cost of $269,400,000, was also submitted by the Canadian section of the Board, in which it was proposed to locate the upper dam at Crysler Island, about 7 miles downstream from the location considered in the previous Two Stage Plan. In this plan, the upper dam with two powerhouses (299,000 horsepower installed capacity each) would be a continuous structure across the river at Crysler Island with a short canal containing one lock on the United States side. Other works would be the same as in the original Two Stage Plan.

16. Great Lakes to Hudson River Water report - 1926. - In a report on "Waterway from the Great Lakes to the Hudson River" transmitted to Congress December 6,1926 (River and Harbor Committee Document No. 7, 69th Congress, 2nd Session), the Chief of Engineers, U.S. Army, pointed out the economy of providing a deep draft channel via the St. Lawrence River as compared with a route across New York to the Hudson River. He also pointed out the value of power development in the St. Lawrence and expressed the view that a waterway should be provided between the Great Lakes and the sea for ocean vessels.

17. Canadian Conference of Engineers report - 1929. - After the 1926 report of the Joint Board of Engineers had been submitted, studies of the International Rapids section were continued by a group of Canadian engineers consisting of the Canadian members of

the Joint Board and two engineers representing the Province of Ontario. A revised version of the Crysler Island Two Stage Plan was developed and a report thereon was submitted by the group to the Secretary of State for External Affairs of Canada in 1929. The revised plan recommended was substantially that of the alternate plan of the Canadian members of the Joint Board with only minor changes in water levels and powerhouse locations. The report, known as "The Report of the Canadian Conference of Engineers", was printed by the Canadian Government.

18. New York Plan - 1931. - An Act by the State of New York, Approved 29 March 1930, provided for the appointment of a Commission consisting of five members, "To devise and report a plan or plans for the development of hydroelectric power in the St. Lawrence River." An Advisory Board of Engineers was established to assist the Commission, and a report presenting a single stage plan known as the New York Plan for development of the International Rapids Section was submitted January 15, 1931, and was printed by the State. The principal features of this plan are: a main dam in the channel south of Barnhart Island and secondary dams closing the upper ends of the two channels north of Barnhart Island; a spillway and two powerhouses near the mouth of Grass River at the head of the channel south of Cornwall Island (capacity 2,200,000 horsepower) with a forebay extending across the United States mainland between the powerhouses and Robinson Bay; a 27-foot channel for navigation in the river

channel north of Cornwall Island, with a double lift lock on Barnhart Island near the main dam; the south Galop channel closed by a dam provided with gates for flow regulation; and an uncontrolled channel through Galop Island for navigation.

19. Reconvened Joint Board of Engineers report - 1932. - On January 23, 1930, the Joint Board of Engineers which prepared the engineering report submitted November 16, 1926, was reconstituted by the appointment of three new United States members and was requested to resume studies and to report on a mutually agreeable plan for improvement of the International Rapids Section. This Board submitted a report April 9, 1932, providing for a Two Stage Plan substantially the same as the alternate plan developed by the Canadian members of the original Joint Board of Engineers and later modified by the Canadian Conference of Engineers. This plan was considered to be feasible and safe from an engineering point of view. Its cost eas estimated at $274,742,000. This report (printed in Canada) served as a basis for negotiations for the proposed treaty. The treaty, which provided for developments along the lines presented in the engineering report, was signed by representatives of both governments July 18,1932. The proposed treaty was submitted to the United States Senate, but failed of ratification. With the message of the President to Congress Jenuary 10, 1934, urging ratification of the proposed treaty, there were transmitted reports from four government agencies relative to the engineering and economic advisability of

the project (Senate Document No. 116, 73rd Congress, 2nd Session).

20. Department of Commerce report - 1940-41. - In 1940-41, the Secretary of Commerce submitted a series of reports to the President, covering the history, existing and potential traffic, and probable effects of a seaway. These reports were published in seven parts by the Government Printing Office.

21. Joint Report of the Canadian Temporary Great Lakes - St. Lawrence Basin Committee and United States St. Lawrence Advisory Committee - 1941. - Studies by engineers of the Canadian Department of Transport in 1939 led to the development of what was called the "238-242 Controlled Single Stage Project." In October 1940, the Canadian Temporary Great Lakes - St. Lawrence Basin Committee and the United States St. Lawrence Advisory Committee were constituted by their respective governments. At a joint meeting held in Ottawa January 3,1941, they received a final report from a board of engineers appointed the previous year, in which the board presented a description and estimate of cost of the "238-242 Controlled Single Stage Plan" and stated that, in the opinion of the board, this plan was "the best from an engineering and economic point of view, bearing in mind the requirements of navigation and power and the protection of down river interests." The joint committees thereupon submitted the engineers' report to the President of the United States and the Prime Minister of Canada with the recommendation that "in the event that the Governments decide to proceed with the development of the International Rapids Section of the St. Lawrence

River, the work be undertaken in general accordance with the plan of the '238-242' Controlled Single Stage Project described therein." The principal features of this plan are:

a. A control dam in the vicinity of Iroquois Point.

b. A dam in the Long Sault Rapids at the head of Barnhart Island and two powerhouses, one on either side of the International Boundary, at the foot of Barnhart Island.

c. A side canal, with one lock on the United States mainland, to carry navigation around the control dam, and a side canal, with one guard gate and two locks on the United States mainland south of Barnhart Island, to carry navigation from above the main Long Sault Dam to the river south of Cornwall Island. All locks to provide a 30-foot depth of water on the miter sills and to be of the general dimensions of those of the Welland Ship Canal. All navigation channels to be excavated to 27-foot depth.

d. Dikes, where necessary on both sides of the river, to retain the pool level above the Long Sault Dam.

e. Channel enlargement from the head of Galop Island to below Lotus Island designed to give a maximum velocity in the navigation channel south of Galop Island not exceeding 4 feet per second at any time.

f. Channel enlargement between Lotus Island and the control dam and from above Point Three Points to below Ogden Island designed to give a maximum mean velocity in any cross-section not exceeding 2.25 feet per second with the flow and at

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the stage to be permitted on January 1st of any year, under regulation of outflow and levels of Lake Ontario.

g. The necessary railroad and highway modifications on either side of the river.

h. The necessary works to permit the continuance of 14-foot navigation on the Canadian side around the control dam and from the pool above the Long Sault Dam to connect with the existing Cornwall Canal.

i. The rehabilitation of the towns of Iroquois and Morrisburg, Ontario.

j. All the works in the pool below the control dam to be designed to provide for full Lake Ontario level but initially the pool to be operated at a maximum elevation of 238 feet above mean sea level.

22. Executive Agreement - 1941. - Following the submission of this report, diplomats of the two countries continued negotiations with the assistance of the joint committees and on March 19, 1941 an agreement was signed by the Governments of the United States and Canada providing for the construction of dams and power works in the International Rapids section and for the completion of a deep waterway throughout the Great Lakes - St. Lawrence River system. The President transmitted the agreement to Congress March 21, 1941 with a message stating that the terms of the agreement contemplated that it should be made effective by concurrent legislation of Congress and the Canadian Parliament. The text of the agreement was

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published in House Document No. 153, 77th Congress, 1st Session. The necessary legislation was not adopted. The agreement provided for the construction of the entire waterway from the head of navigation on the Great Lakes to tidewater. It left the present equal division of water power in the rapids of the St. Mary's River unchanged. Special provision was made for changes in the division of power then in effect at Niagara Falls. It provided for equal division of the potential power in the International Rapids section after deductions for water diverted into this basin from other basins by either country and left Canada with the sole right to develop the power of the Canadian section of the St. Lawrence River. The agreement also provided that the necessary improvements in the connecting waters between Lakes Superior and Huron and between Lakes Huron and Erie, including a new lock at Sault Ste. Marie, should be undertaken by the United States; that the deepening of the Welland Canal and the improvements in the Canadian section of the St. Lawrence River should be executed by Canada with the understanding that a 27-foot navigation channel through these reaches would be completed by 1948; and that the improvements within the International Rapids section of the St. Lawrence River should be carried out in accordance with the "238-242 Controlled Single Stage Plan", and under the supervision of an International Commission, the cost of the various features in this section to be divided according to rules laid down in the agreement. The division of the work and

cost was such that each country would pay approximately half of the cost of the entire project, credit being allowed for certain work already done by each country. On March 19, 1941, an agreement was also made between the Canadian Government and the Province of Ontario under which, on payment of certain sums, the Canadian powerhouses would be operated and the power distributed and sold by the Hydroelectric Power Commission of Ontario.

23. St. Lawrence River District report - 1942. - On October 25, 1940, the St. Lawrence River District of the Corps of Engineers was established. This office investigated the sites of proposed structures, investigated land titles and prepared preliminary plans and specifications. The final report of the district was submitted April 30, 1942 and the district was abolished May 1, 1942. On the basis of additional surveys and subsurface explorations and the opinions of numerous consultants, this report recommended the following changes in the original "238-242 Plan."

a. Relocation of the Long Sault Dam to a point approximately 1,000 feet downstream.

b. Realinement of the powerhouse by shifting the Canadian end about 2,500 feet downstream and the United States end about 800 feet downstream.

c. Realinement of the Long Sault navigation canal.

d. Realinement of navigation channels between Chimney Point and Morrisburg, Ontario.

e. Changes in channel dimensions in the vicinity of Galop Island to limit the velocity to approximately 4 feet per second.

24. The cost of the recommended plan was estimated at $287,981,000. The report also discussed an alternate plan proposing a navigation channel in a cut through Galop Island instead of enlarging the natural channel south of the island. The alternate plan would have a higher cost but would result in an improved navigation channel. On the basis of model studies and subsurface investigation subsequent to submission of the report, it was found that the recommended plan would not reduce velocities to 4 feet per second and that the cost of the alternate plan could be reduced to nearly that of the recommended plan. Since the alternate plan provided better navigation conditions, fewer construction difficulties, and slightly higher power heads, an Addendum, dated 1946, to the 1942 report recommended adoption of the alternate plan.

25. Regulation Method No. 5. - The Canadian Department of Transport studied the problem of regulation of levels of Lake Ontario and developed "Regulation Method No. 5" which most nearly satisfies all the requirements pertaining to regulation. This plan was first proposed in September 1940 and has been revised to August 1952, in reports printed by the Department. The requirements to be met are:

a. To keep the fluctuations of the levels of Lake Ontario within the range that would have occurred in the past, assuming a continuous diversion of 3,200 cubic feet per second at Chicago and present outlet conditions.

b. To maintain the low water levels of Montreal Harbor.

c. To maintain low water flows without material changes between December 15 and March 31 in order that the difficulties of winter operation of the power plants may not be aggravated.

d. To maintain flows during the first half of April no greater than would naturally occur, in order to avoid the danger of aggravating the spring rise of water during the breakup of the ice below Montreal.

e. To avoid any material increase in the amount and duration of high river flows during May, in order not to increase, or lengthen the period of, high water levels in Lake St. Louis during the flood season in the Ottawa River.

f. To keep the fluctuations in mean monthly discharges within the existing limits.

g. To hold back the natural excess outflow during the early summer months, in order to raise the levels of Lake Ontario.

h. To secure the maximum dependable flow throughout the year for power purposes.

26. Federal Power Commission engineering report. - In connection with an application by the Power Authority of the State of

New York for a license to develop the United States portion of the power in the International Rapids section, in conjunction with a Canadian development by the Hydroelectric Power Commission of Ontario, the Federal Power Commission prepared an engineering report, first presented in September 1948 and revised in November 1952. The proposed project would have an installed capacity of 1,880,000 kilowatts, divided equally between the two countries. The project would include the necessary facilities to continue 14-foot draft navigation through the construction period, but the 27-foot waterway would be built separately by the Canadian Government. Project features would be generally similar to the plan of the St. Lawrence River District. The United States portion would have a dependable capacity of 700,000 kilowatts and an average annual energy output of 6,300,000,000 kilowatt-hours (6.3 billion Kwh). The power could be sold as soon as it could be made available. At December 1950 price levels, the Power Authority share of the cost would be $260,850,000. The Power Commission concluded that the project would be economically feasible and would be best adapted to a comprehensive plan for development of the river.

27. Recent actions. In a reference dated June 25, 1952, the Governments of the United States and Canada requested the International Joint Commission to determine, having regard to all other interests, whether measures could be taken to regulate the level of Lake Ontario for the benefit of property owners on the shores of

the lake in the United States and Canada so as to reduce the extremes of stage which have been experienced. The Commission has appointed an International Lake Ontario Board of Engineers to make the necessary studies and report thereon. On June 30, 1952, by an exchange of notes, the United States and Canada agreed on a plan of development to be submitted to the International Joint Commission. Under this plan, Canada would build a 27-foot navigation channel whenever the power facilities were built by suitable entities in each country. On October 29, 1952, the International Joint Commission approved the applications by the two governments. On November 4, 1952, Canada informed the United States that it considered the 1941 Executive Agreement to have been superseded by the proceedings before the International Joint Commission. The Federal Power Commission issued a license to the Power Authority of the State of New York July 15, 1953, to design, construct, operate and maintain the power project only. Legislation was passed by Congress in 1954 which would set up an agency for construction of navigation facilities on the United States side on a self-liquidating basis. A subsequent agreement between the United States and Canada provides for construction of the Long Sault Canal by the United States with both countries reserving the right to construct canals around Iroquois Dam.

POTENTIAL COMMERCE

Ind. A report by the Canadian Department of Trade and Commerce in 1951 concluded that traffic of 44.5 million tons, based generally

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upon actual traffic patterns of 1947, would be available to a 27-foot channel. This estimate is close to the maximum capacity of the canal, on the basis of estimated lockage times for this canal and average loads reported at the Sault Ste. Marie canals. The Canadian estimate divides the potential commerce as shown in Table 2.

Table 2 - Potential commerce,
St. Lawrence Seaway
Subregion "C"

Commodity	Quantity in thousands of short tons		
	Downstream (northeast)	Upstream (southwest)	Total
Wheat	6,000		6,000
Other grain	2,200		2,200
Flour and mill products	2,200		2,200
Iron ore		20,000	20,000
Iron and steel	1,586		1,586
Paper		850	850
Woodpulp		300	300
Pulpwood		865	865
Lumber		375	375
Hard coal		500	500
Soft coal	3,000	500	3,500
Coke	200		200
Petroleum and products	50	1,041	1,091
Autos and parts	790		790
Fertilizer	75		75
All other	2,000	2,000	4,000
Totals	18,101	26,431	44,532

PLAN OF IMPROVEMENT

29. General. - The plan of improvement described below and shown on Plate 2 is basically that developed by the Corps of Engineers. The New York State Power Authority is reviewing

that plan and prior plans and making additional studies to develop a new design for the power facilities. The report of the Corps of Engineers recommended a navigation channel of 27-foot depth on the United States side of the river. The Canadian Government has made studies of a canal on the Canadian side, and the Corps of Engineers is now making studies for a final design of the navigation features. Plate 2 shows the center line of the Canadian route and more detailed information on the United States route.

30. General features. - The proposed improvement of the International Rapids Section of the St. Lawrence River includes the following general features:

a. A dam for control of the flow of the river (Iroquois Dam).

b. A system of structures to create a head and generate power (Long Sault Dam, Barnhart Island Powerhouse and connecting dikes).

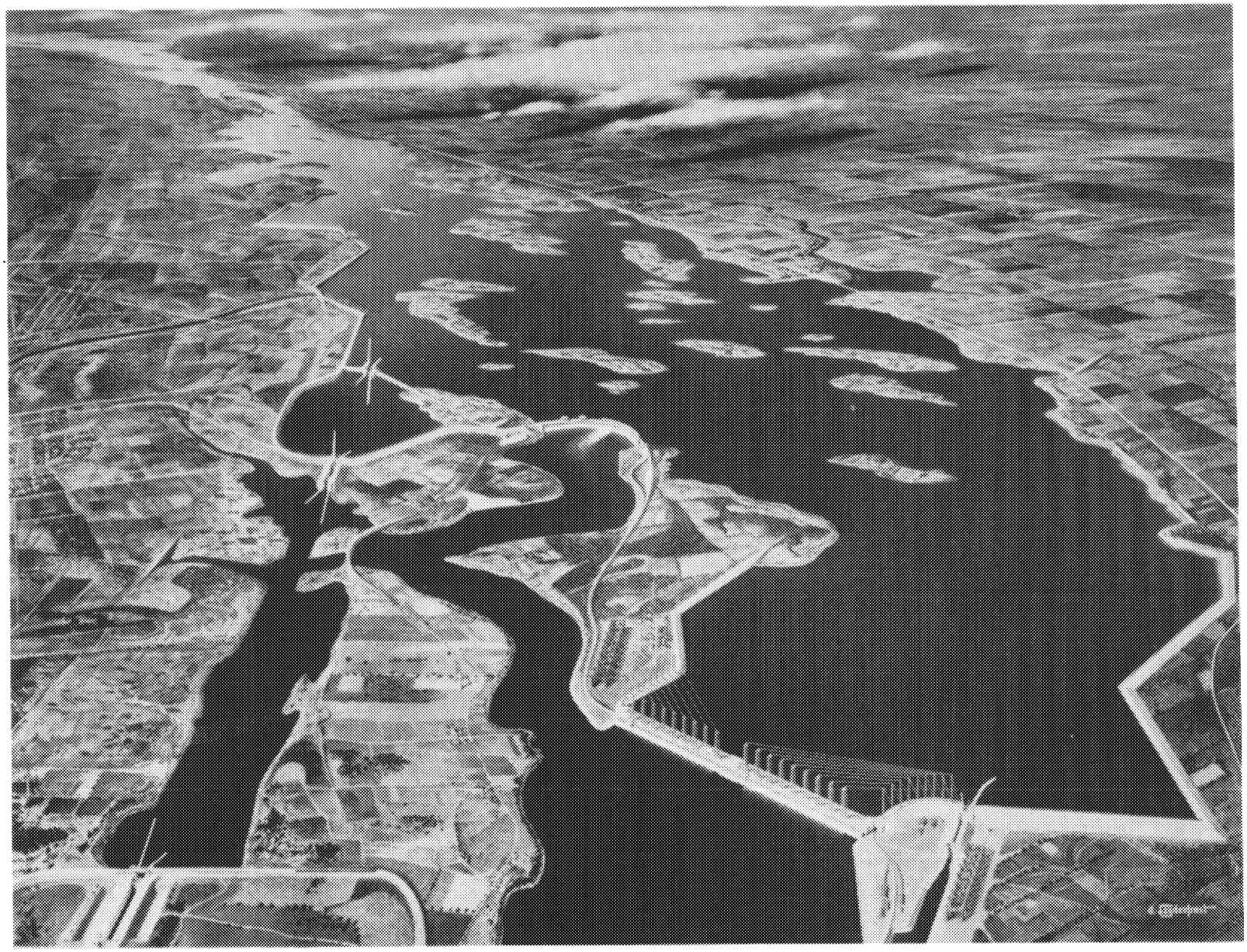
c. Canals for navigation between the pools created by these dams and Lake St. Francis.

d. Channel enlargement where necessary to provide adequate width or depth for navigation or to reduce velocities.

e. Incidental works to reduce or repair damages caused by other works (side dikes and relocations).

31. Design criteria. -

a. Excavation and embankment. - A maximum slope of one on two was established for all hydraulic and navigation cuts in



The St. Lawrence Seaway and Power Project as it will appear when completed. Subregion "C".

~~form~~ firm material, to reduce maintenance to a minimum. Slopes in soft material were designed by the circular arc method to provide a factor of safety of at least 1.5. Top widths of dikes and wing dams were usually dependent on the use of the embankment for highways and railroads. Design of all embankments considered economy of construction, control of seepage, and stability of the structure. Cut off trenches were included for all embankments over 10 feet high.

b. Criteria for navigation channels. - Channels were designed to have side slopes of 1 vertical on 2 horizontal and at 27-foot depth minimum bottom widths of 192 feet for channels flanked by 2 embankments; 292 feet for channels flanked by one embankment; and 442 feet for channels with both sides submerged, the usual case. Channels would be wider where cross currents make navigation difficult. The width would also be increased where necessary to keep velocities under 4 feet per second for at least 97 percent of the navigation season. Alignment would be generally similar to that of Great Lakes connecting channels.

c. Lock dimensions. - Lock dimensions would conform to those of the Welland Ship Canal. Chambers would be 80 feet wide with a length of 766 feet between breast wall and fender and a depth of 30 feet on sills.

d. Channel enlargement for power. - In studies of ice formation, it was found that: (1) where swift currents in the river prevent the formation of a fixed ice sheet, fine crystals (frazil

ice) form and float downstream to attach themselves to fixed objects or lodge in quiet water; (2) a continuous ice cover forms only when the average velocity is less than 1.5 feet per second; and (3) floating ice and slush pack against the upstream edge of a fixed ice cover and extend it upstream against velocities less than 2.5 feet per second. In order to keep ice from interfering with power production, the following criteria were adopted: (1) where possible, provide mean velocities not exceeding 1.5 feet per second to permit formation of natural ice cover; (2) provide artificial barriers against which floating ice can pack to start an ice sheet; and (3) whenever possible, provide mean velocities upstream from the barriers not exceeding 2.25 feet per second.

32. Channel work: vicinity of Galop Island. - There is to be provided a channel 1,400 feet wide with a bottom elevation of 214 feet from Chimney Point through Galop Island to below Lotus Island. This channel is needed to reduce velocities to those required for navigation. The plan would also include enlargement of the channel south of Lalone and Lotus Islands and construction of training dikes along the new channel to reduce cross currents. The final location of excavation and dikes would be determined after further model tests and studies. These tests would also determine the location of ice cribs to be placed near the head of Galop Island. During the ice season, these cribs would be connected by floating booms against which floating ice could pack and which would hold the ice in the spring until it melted.

33. Channel work: vicinity of Sparrowhawk Point. - Work in this section would consist of making a cut through Sparrowhawk Point with its bottom at elevation 205 feet and removal of the southerly part of Toussaints Island and shoals offshore to an elevation of 213 feet, mean sea level. These cuts are necessary to reduce velocities to 2.25 feet per second and would also improve the alignment of the navigation channel. The reduced velocities should assist in formation of an ice cover upstream from Iroquois Dam.

34. Iroquois Dam. - Iroquois Dam would be a buttressed, concrete gravity structure consisting of 40 gate openings with their sills at an elevation of 200 feet, flanked by concrete gravity nonoverflow sections and earth wing dams extending to high ground at each end. The center line of the spillway would be a circular arc with a radius of 1,700 feet. The over-all length of the masonry would be 2,776 feet of which 2,000 feet would be gated, and the length of the entire structure, 3,600 feet. The deck of the structure would rest on piers 10 feet thick between gates and would support a highway and two traveling cranes for gate operation. The top of the vertical-lift gates would be at an elevation of 248 feet and the gate sill, at an elevation of 200 feet. The dam would be used to control the flow of the river, and to assure the formation of an ice cover upstream. A modification of this plan now being considered would provide for a straight dam with 32 gate openings at Point Rockway. The United States end of the structure would extend across

a cut in the point. Part of Iroquois Point would also be removed. Model tests indicate that this arrangement would reduce head losses and consequently increase power generation. The cost would be lower since the part of the dam on Point Rockway could be built in the dry. The modification will probably be adopted.

35. Point Rockway Canal. - A canal and lock would be necessary to carry navigation around Iroquois Dam and the rapidly flowing reach in the vicinity of Point Rockway. In the St. Lawrence River District report, it was proposed to build a canal in a natural depression extending across Point Rockway. The canal would have a bottom width of 442 feet throughout and would be flared at both ends to provide safer access in areas with severe cross currents. A large amount of ledge rock must be removed in the upper part of the canal, but would be satisfactory for concrete aggregate and bank protection for Iroquois Dam. Similar rock in the lower part of the canal could be used in the lock and dikes. The proposed lock would be founded on ledge rock near the lower end of the canal and would have a lift ranging between 1 and 5 feet. The gates would be of the sector type and would be designed so that the lock could be filled or emptied by operation of the gates. Use of this type of lock gate would eliminate the need for a guard gate. Approach walls would extend 1,200 feet beyond each end of the lock and would be flared to permit mooring a vessel without interference with other traffic. A bridge across the upper end

of the lock would carry the access highway to Iroquois Dam. Earth wing dikes extending to high ground on each side of the lock would complete the dam across the valley in which the canal would be located and would carry the highway.

36. Channel work; Point Three Points to Canada Island. - Work in this area would include nine separate cuts and removal of a portion of the Morrisburg Canal Dike. The purpose of the cuts would be reduction of velocities to 2.25 feet per second to permit formation of an ice cover, but some of them would also be used as parts of the navigation channel. The two cuts at Point Three Points would be excavated to a bottom elevation of 200 feet, mean sea level, the North Cut in Little River to 215 feet, and the canal dike removed to 208 feet. The bottom elevation in the other cuts would be 210 feet. As much as possible of the cuts would be excavated in the dry. The remainder of the cuts and the dike removal would be done with floating plant after the pool above Long Sault Dam was raised sufficiently.

37. Long Sault Dam. - Long Sault Dam would be curved in plan with a radius of 1,600 feet. The maximum height of the structure would be 145 feet above the foundation. The spillway section would consist of 30 gate openings 50 feet wide separated by 10-foot piers. The gates would be 26 feet high on a sill at elevation 217. The roller type vertical lift gates would be operated by fixed hoists and two traveling cranes. The Long Sault Dam and attached dikes

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would, with the Barnhart Island Powerhouse and dikes, control all channels of the river and create a power pool, and would serve as a spillway for the pool. A railroad and highway across the dam would provide access to the powerhouse.

38. Barnhart Island powerhouse and dikes. - The Barnhart Island Powerhouse would be the largest single feature of the project. It would consist of a massive concrete intake structure with the powerhouse itself on the downstream side of and integral with the intake. Economy of design would be achieved by eliminating the conventional powerhouse superstructure in favor of simple hatch covers to protect the generators against the weather. The structure would be about 3,200 feet long, half on each side of the international boundary. Starting from midstream, each half would consist of an ice sluice, 16 generating units and two ice sluices, with an erection bay spanning them, at the abutment. The turbines would be designed to develop 71,000 horsepower each under 81 feet of head at best gate and 88,800 horsepower under a maximum head of 87.5 feet at full gate opening. The generators would be rated at 57,000 kilowatts, 60-cycle, 13,800 volts. Step-up transformers would be located on the downstream side of the powerhouse deck, connected to switchyards on shore by cables in galleries in the powerhouse structure. Earth dikes on each bank would connect the ends of the structure with high ground.

39. Long Sault Canal. - This canal would carry navigation past the Long Sault Dam and the Barnhart Island Powerhouse. The canal would include a guard gate and two locks with a total lift of approximately 90 feet. The topography is adapted to an intermediate pool with surface at approximately elevation 200, thus making the two lifts nearly equal. There are large bodies of soft clay of low bearing power along the canal so that it would be necessary to locate spoil banks and dikes at a considerable distance. As a result, both banks would be submerged for the greater part of the canal length and the bottom width would accordingly be set at 442 feet. Cuts through Richards Point, Croil Island, Long Sault Island, and a point west of Hopsons Bay would be made to straighten the channel and eliminate sharp curves in the natural channels. Material excavated from the canal would be used in dike construction. The Long Sault Guard Gate would consist of two concrete walls 110 feet apart with a sector-type gate. The gate sill would be at an elevation of 206 feet. The purpose of the gate would be to prevent flow from the upper pool in the event of the failure of the Robinson Bay Lock or its wing dikes. Both approaches to the guard gate would be provided with guide and wing walls similar to those at the locks. Dikes would be provided on each side of the gate structure to retain the pool above Long Sault Dam. The gate bay walls and sills would be founded on steel bearing piles and the approach walls on compact

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till. The gate would consist of two leaves each 45.5 feet high with a radius of 67 feet, which would swing into recesses in the wall when open. The lift at Robinson Bay Lock would vary from 38 to 42 feet under normal conditions, with provision for greater lifts under extreme conditions. The maximum lift would be 49 feet. Dikes on each side of the lock would confine a navigation pool above the lock and provide access for the railroad and highway to the powerhouse which would cross the upper end of the lock on a swing bridge. The lock chamber would be founded on ledge rock, but the approach walls would rest partly on compact till and partly on bearing piles. Two sets of miter-type gates would be provided at each end of the lock to insure continuity of operation. The lock chamber would be filled or emptied through culverts in the side walls. Grass River Lock, near the lower end of the canal, would have a lift varying ordinarily from 43 to 46 feet. The maximum lift would be 50 feet. Dikes on each side would confine the pool between the locks and provide access for the relocated railroad and highway crossing the upper end of the lock. The lock chamber would be founded on ledge rock. The lower approach walls would be constructed in the wet and would consist of concrete walls spanning a series of sheet pile cells filled with granular material. The gates and

other equipment would be similar to those at Robinson Bay Lock. Because of strong cross currents in the river at the lower entrance to the canal, the canal would be flared below the Grass River Lock.

40. Channel work: Barnhart Island to Lake St. Francis. - A hydraulic model study is considered necessary to determine the channel dimensions to be adopted finally for this work, which would be divided into three parts: the main river below Barnhart Island Powerhouse, and the channels north and south of Cornwall Island. The purposes of the work are reduction of velocities in the South Channel for navigation and lowering of the tail water at the powerhouse. The main river excavation near the powerhouse would be solely for power and the amount to be excavated would be determined by balancing the cost of excavation against resulting power benefits. The North Channel excavation has been tentatively designed to provide a channel 600 feet wide at a bottom elevation of 131 feet. The bottom elevation was set to reduce rock excavation. The purpose of the excavation is primarily to reduce velocities in the South Channel, but the work would also lower the tailwater and create power benefits. In the South Channel, a channel 1,000 feet wide at grade elevation 121 would be provided above Mile 109.8 (from Tibbetts Point) to reduce velocities below 4 feet per second for navigation. Downstream from this point, the water surface is that of Lake St. Francis and velocities are satisfactory for navi-

gation, so the channel to be provided would be of the size required for navigation, 442 feet wide at grade elevation 124. Dredging in the South Channel would be more economical if the North Channel work were completed first.

41. Side dikes. - Dikes generally parallel with the river would be required on both sides to prevent overflow from the pool behind Long Sault Dam into adjacent watersheds. These include the Coles Creek, Bradford Point, Louisville Landing, and Richards Landing Dikes in the United States and Bergen Lake, Moulinette, Mille Roches, and Cornwall Canal Dikes in Canada. As far as possible, these dikes would be constructed from material available from nearby excavations.

42. Relocation of canals. - In order to maintain 14-foot navigation during the construction period, it would be necessary to relocate the Cornwall Canal between Locks 19 and 20 and to raise walls and dikes at Lock 21 and at Lock 25 near Iroquois. Construction of Iroquois Dam would raise the level of the upper pool at Lock 25, and the coping of the lock and the flanking dikes must be raised above the new level. The dike north of the Barnhart Island Powerhouse would cross the existing Cornwall Canal. It is proposed to relocate the canal between Locks 19 and 20 for a length of 4,058 feet and construct a combined lock and guard gate structure where the dike crosses the new alinement. The sill

of the upper lock gate would be built so that the lock could be used before the upstream pool was raised. The lock gates would be in two sections horizontally so that the lower section could be closed permanently after the pool was raised. The guard gate and its sill would be installed during a winter season after the pool was partly raised in order to reduce the height of the gate. It would also be necessary to raise the coping of Lock 21 and dikes between the river and canal in the vicinity of that lock to permit continued 14-foot navigation during raising of the Long Sault Dam pool.

43. Massena Canal intake. - The Massena Power Canal diverts 25,000 cubic feet per second from the channel south of Long Sault Island for power generation at the aluminum plant in Massena. The canal also furnishes the village water supply. Construction of Long Sault Dam would raise the river level at the canal intake and, since the canal has no spillway facilities, could cause damage along the canal if it were left open. Although no power would be generated at Massena after completion of the project, since the same water could be used more efficiently at the Barnhart Island Powerhouse, the Massena plant would be kept in operation until the Barnhart Island plant starts. It has not been decided, however, who would pay for the intake works. A control structure

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and wing dams would be built at the head of the present canal. The control structure would be at the side of the existing canal in order to permit construction in the dry. After completion of the structure, canal flows would be diverted through it and the old canal would be blocked by a wing dam. The structure would consist of eight tractor gates, 9 by 14 feet, operated by float-controlled individual hoists. Bottom discharge would be used to reduce ice effect. The intake works would maintain a constant flow in the canal at all river stages, without respect to power-house demand. After operation starts at Barnhart Island, the flow in the canal would be reduced to that needed for water supply.

44. Railroad relocations. - The pool created by Long Sault Dam would flood the double-track Montreal-Toronto line of the Canadian National Railway, paralleling the river. The line would be relocated at a higher elevation north of the present line. The new line would be 23 miles long with three bridges. The dock facilities and depot of the Norwood and St. Lawrence Railroad at Waddington would also be flooded. The dock and depot would be relocated at a higher elevation one-half mile downstream, where the new pool would provide deep water. About one-half mile of new track would be required and two bridges and their approaches would be raised. Construction of a canal on the United States side would require relocation of the Ottawa Branch of the New York Central Railroad. The existing bridge across the channel south

of Cornwall Island lacks sufficient clearance for navigation and swift currents make a drawbridge undesireable. The proposed line would leave the existing line north of the Raquette River bridge and go west to cross the Grass River about 3/4 mile above its mouth. It would then cross the upper end of the Grass River lock and go north along a dike before turning east. A new bridge would be required across Polly's Gut, from which the line would cross Cornwall Island to join the existing line south of the present bridge over the channel north of the island. If the canal were constructed on the Canadian side, these changes would not be necessary, but some changes would be necessary in the vicinity of the north channel.

45. Highway relocations. - Canadian Highway 2 parallels the St. Lawrence River on the north side and would be flooded for 26 miles between Iroquois and Cornwall. The highway would be relocated generally parallel to existing and relocated lines of the Canadian National Railway. State Highway 37 would be relocated for 6 miles east of Waddington and relocation of State Highway 37B between Bradford Point and Richards Point would require 5 miles of new road and improvement of 2 miles of existing unimproved road. The highway which uses the New York Central bridges at Cornwall Island would be relocated near the railroad relocation and would use the same bridges as the relocated railroad.

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46. Rehabilitation of villages. - The villages of Waddington, New York, and Iroquois and Morrisburg, Ontario would be partially inundated. It would be necessary to relocate utilities, streets, and some buildings outside the flowed area, and, in a few cases, to underpin foundations of structures left in place.

47. Relocation of transmission line. - A double-circuit transmission line on steel towers, a single-circuit line on wood poles, and private telephone line, all on the same right-of-way, cross the westerly end of the Robinson Bay Lock site and several poles and towers would be surrounded by water in the powerhouse forebay. The lines would be relocated on a single set of steel towers with long spans to reduce foundation costs. The new line would provide clearances of 170 feet over Long Sault Canal; 75 feet over the forebay; and 150 feet over ultimate high water of the Cornwall Canal.

48. Access road and railroad to powerhouse from Canadian side. - To provide access to the powerhouse from the Canadian side, it would be necessary to construct 0.9 miles of highway from Canadian Highway 2, and 3 miles of railroad from the junction of the Canadian National Railway and New York Central Railroad. These would cross the Cornwall Canal at Lock 19 and then follow the existing fill on the river side of the canal.

49. Lands and clearing. - It is proposed to acquire in fee all lands to be occupied by structures or required for construction purposes, and all lands to be flooded below 230 feet. Unrestricted flowage easements would be acquired for lands between elevations of 230 feet. In this way, the parts of the new shore line not occupied by dikes would be left in private possession for recreational development. All trees, brush, buildings, and fences would be cleared from the area to be flooded below 249 feet. A total of 8,242 acres is involved, of which 5,650 acres are in the United States.

50. Work schedule. - The proposed project could be completed in six years to the extent of raising the pool, providing 27-foot navigation, and partial installations in each powerhouse. Remaining work, estimated to require one year more, would consist of completing installations in each powerhouse.

51. Coordination. - Close office and field liaison between the agency constructing the canal and the State Power Authority would be necessary.

COST

52. Estimated cost. - The cost estimates shown in Table 3, at December 1950 cost levels, made by the Office, Chief of Engineers early in 1951, are indicative of the cost of the projects now planned for the International Rapids.

Table 3 - Estimate of first cost, St. Lawrence River, International Rapids separate projects for power and navigation, Subregion "C"

Description		Estimated cost
Works solely for navigation		$ 79,218,000
Works solely for power		
Structures, headrace and tailrace excavation	$138,652,000	
Machinery and equipment	156,788,000	
Subtotal		295,440,000
Works common to navigation and power		
Channel excavation	71,867,000	
Ice cribs	1,170,000	
Iroquois Dam and dikes	20,432,000	
Dikes (detached dikes)	2,462,000	
Massena Canal intake and attached dikes	6,663,000	
Long Sault Dam, diversion cuts and attached dikes	32,533,000	
Relocation of Cornwall Canal	14,431,000	
Work at Lock 25	1,184,000	
Railroad relocations		
Norwood & St.Lawrence Railroad	548,000	
Canadian National Railway	5,941,000	
Clearing of flowage areas	722,000	
Rehabilitation of Morrisburg	7,234,000	
Rehabilitation of Iroquois	4,865,000	
Acquisition of lands		
In United States	12,667,000	
In Canada	21,616,000	
Highway relocation		
United States side	1,768,000	
Canadian side	3,672,000	
Raising Lock 21 and dikes	254,000	
Administrative facilities	2,000,000	
Power distribution facilities for construction	444,000	
Relocation of Transmission lines	334,000	
Subtotal		212,807,000
Total		$587,465,000

53. The cost of additional work to provide a 27-foot channel between Lake Ontario and Chimney Point (Thousand Islands section) was estimated at $1,593,000 at the same cost levels.

54. Annual cost. - The annual cost of project works for power on the United States side (including interest during construction) is estimated at $13,870,000 (money at 3 percent) and the annual cost of transmission at $10,000,000, a total cost of $23,870,000 annually cost of navigation improvements in the International Rapids and Thousand Islands sections would be $5,194,000. Although no figures have been given, it is believed that the cost of the Massena Canal power intake would be justified by the value of power which could be produced during the project construction period.

BENEFITS AND ECONOMICS

55. Power. - On the basis of the installation of 940,000 kilowatts and operation in accordance with Regulation Method No.5, by the Power Authority of the State of New York the dependable hydroelectric power capacity of the United States portion would be 700,000 kilowatts and the average annual energy output would be 6,280,000,000 kilowatt-hours. For purposes of computing transmission costs, a market was assumed with load centers near the project and at Utica, Schenectady, Poughkeepsie, Binghamton, and New York, N.Y., Springfield, Mass., and Burlington, Vt. The average annual cost of power delivered at these points was estimated at 4.12 mills per kilowatt-hour. The cost of fuel-generated power at the load centers was estimated at 6.98 mills per kilowatt-hour. In the assumed market

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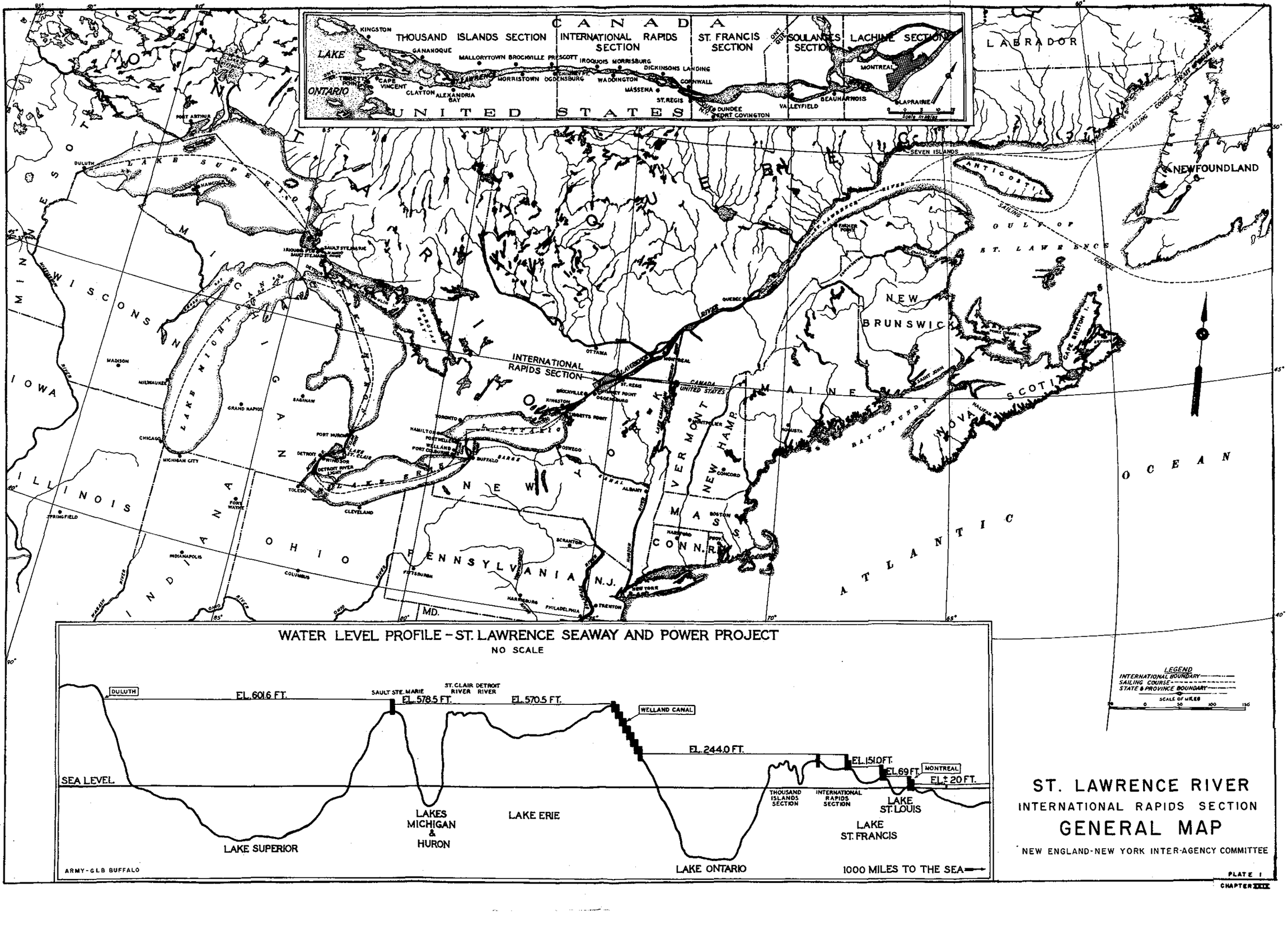
area (the New England States except Maine, and New York east of Rochester), the estimated additional power needs would be 3,500,000 kilowatts between 1955 and 1960. Therefore, the 700,000-kilowatt dependable capacity on the United States side of the St. Lawrence project could be used as fast as units could be installed and the power would be more economical than fuel-generated power. The benefit-cost ratio of this phase of the project would be approximately 1.69 to 1.

56. Navigation. - The Canadian Department of Trade and Commerce estimates savings in transportation costs as a result of the project to be of the order of $50,000,000 or about $1.10 per ton for 44.5 million tons per year.

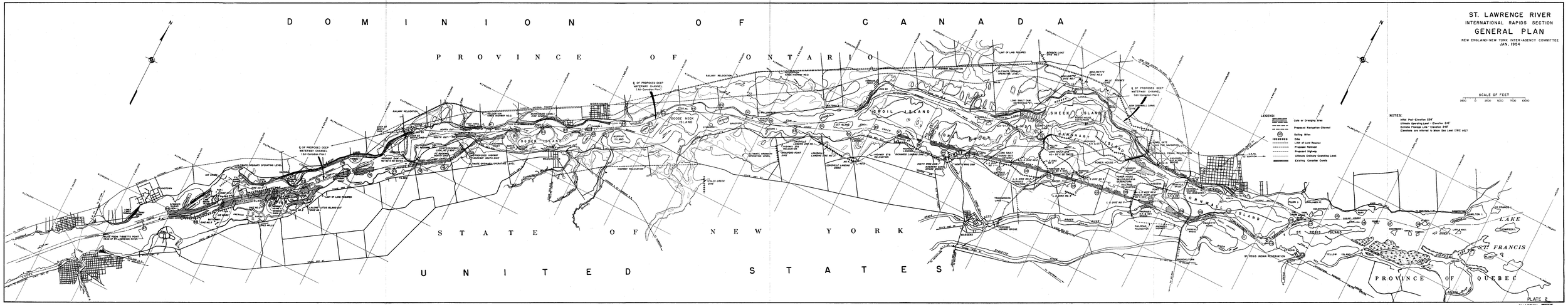


ST. LAWRENCE RIVER
INTERNATIONAL RAPIDS SECTION
GENERAL MAP

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE

PLATE I

CHAPTER XXIX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P R O V I N C E O F O N T A R I O
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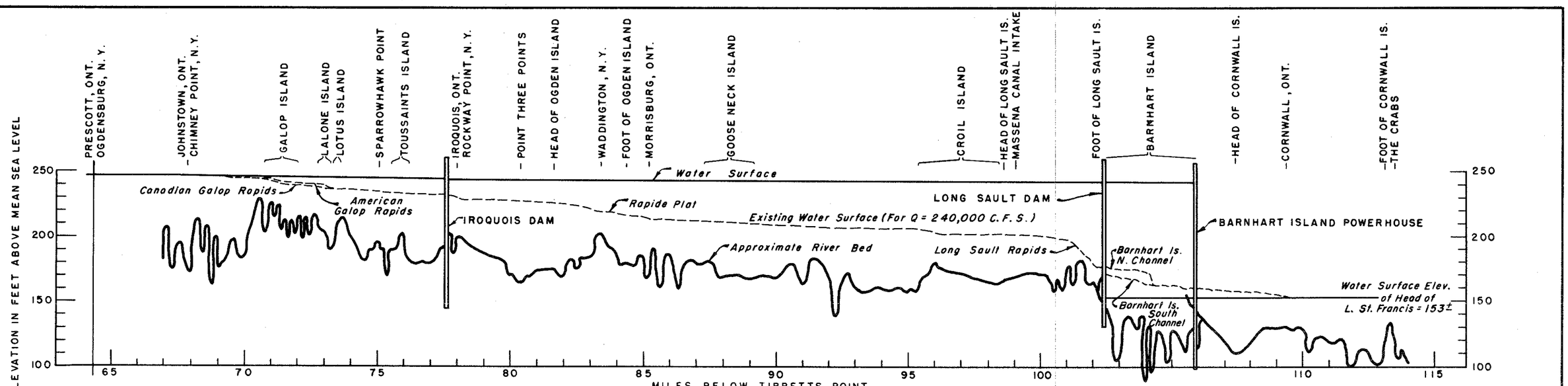
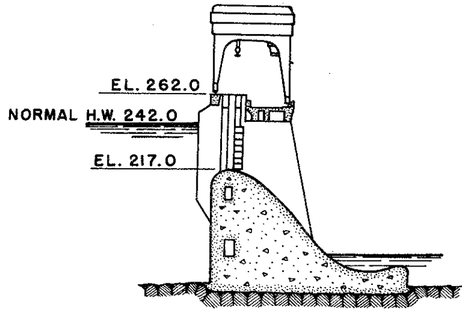
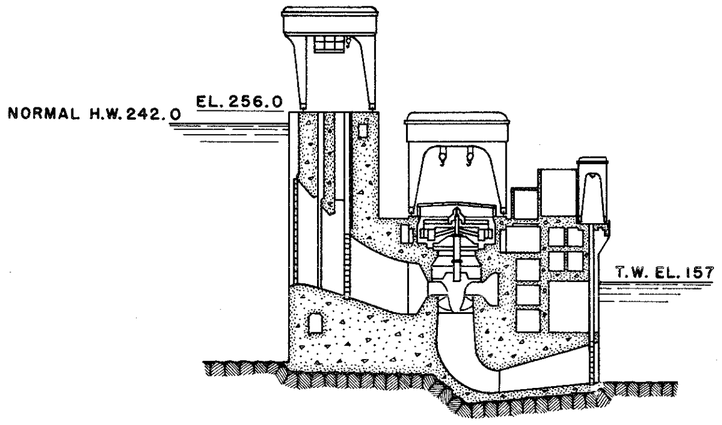
ST. LAWRENCE RIVER
INTERNATIONAL RAPIDS SECTION
GENERAL PLAN
NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
JAN. 1954
SCALE OF FEET
LEGEND:
NOTES:
OSSEE NECK ISLAND
OSSEE ISLAND
CROIL ISLAND
SHEEK ISLAND
SAWYERS ISLAND
BARNHART ISLAND
ST. REGIS ISLAND
LAKE ST. FRANCIS
MASSENA
CORNWALL
ST. REGIS INDIAN RESERVATION
PLATE 2
CHAPTER XXIX



PROFILE ALONG RIVER THROUGH PROPOSED DAMS AND POWERHOUSE



TYPICAL SECTION - LONG SAULT DAM



TYPICAL SECTION - POWER HOUSE

ARMY-GLB BUFFALO

ST. LAWRENCE RIVER

INTERNATIONAL RAPIDS SECTION

PROFILE

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE

OCT. 1954

PLATE 3
CHAPTER XXIX

SECTION II - HARBORS AND BEACH EROSION,
LAKE MEMPHREMAGOG, VERMONT

PHYSICAL DESCRIPTION

1. Lake Memphremagog is located in north-central Vermont and in the southern part of the province of Quebec (see Plate 4). It is 25 miles long and its greatest width is 3 miles, near the southern end just north of Newport, Vermont. The total water surface area of the lake is 37 square miles, with only 10 square miles lying in the United States. The lake contains about 20 small islands, most of them in Canada. Navigation in the lake consists entirely of pleasure boating.

2. Tributary streams. - Lake Memphremagog has many tributary streams. The principal tributaries, all draining into the southern end of the lake, are the Clyde, Barton and Black Rivers. The only outlet is the Magog River in Canada, which flows into the St. Francis River, a tributary of the St. Lawrence River. The streams draining into the lake are not navigable. A power dam at the outlet in Magog River obstructs passage of craft to and from the lake. Navigation is generally restricted by ice conditions to 7 months of the year, from April to October.

3. Shore characteristics. - The shore line of the United States portion of Lake Memphremagog, including South Bay at its southern end, is over 20 miles long. Surrounding terrain is generally hilly to mountainous and elevations rise to a maximum of about 500 feet above

lake level within one mile from the shore. An extensive marshland occupies the southern end of the lake. Rock outcrops of granite and limestone are frequent north of the city of Newport. Much of the bedrock is covered by glacial till from 40 to 50 feet thick containing sediments which are generally poorly sorted. Steep banks of this material are subject to erosion by wave and ice action. The banks are fronted by narrow beaches, many of which are submerged during high lake level. Sources of beach building material are probably the banks and the sediments carried into the lake by tributary streams.

4. Lake levels. - Based on a report submitted in 1934 by the International Lake Memphremagog Board, an agreement was reached by the Governments of the United States and Canada whereby the lake level would be maintained between elevations 683.00 feet and 679.28 feet, U. S. Coast and Geodetic Survey Datum, 1929 General Adjustment. Maximum and minimum elevations of record have been 685.92 feet and 679.69 feet, respectively.

5. Prevailing winds. - U. S. Weather Bureau records for Newport indicate that the prevailing direction of winds on Lake Memphremagog is from the south. The greatest fetch in the United States section of the lake is from the north making winds from this direction the most effective in generating waves adversely affecting navigation and the shore.

USE OF THE LAKE AND TRIBUTARY AREA

6. The area tributary to the southern portion of Lake Memphremagog is primarily rural, the largest community being the city of Newport, Vermont with a 1950 population of 5,200. Farming is the principal

source of income. Dairying comprises over 80 percent of farm revenue. Other economic activities include the manufacture of food products, apparel, lumber and lumber products, leather and machinery. The shore is accessible by means of first class U. S. and State highways. The Canadian Pacific and Boston and Maine Railroads serve the area.

7. Shore development. - The development of the shore frontage is both recreational and agricultural in character. The area is dotted with numerous summer cottages and camps. A large part of the land in the vicinity of the lake is intensely farmed.

8. Terminal facilities. - The only pleasure boat terminal in the American portion of the lake is a boat yard located in Newport. This boat yard provides 60 feet of landing space, 30 slips and an open water anchorage area with depths ranging from 3 to 15 feet. Facilities for servicing, repair and winter storage of boats are available. The facilities are considered adequate for existing and prospective pleasure boating needs.

9. Pleasure boating. - On the American side of the lake, the fleet of pleasure boats totals 55, about one-half of which moors at the boat yard in Newport. The fleet consists of 4 cruisers, 5 sailboats, 1 auxiliary sailboat, 25 inboards and 20 outboards. These boats have lengths varying from 12 to 30 feet and drafts from 0.5 to 4 feet. About 100 pleasure boats from the Canadian side of the lake annually visit Newport.

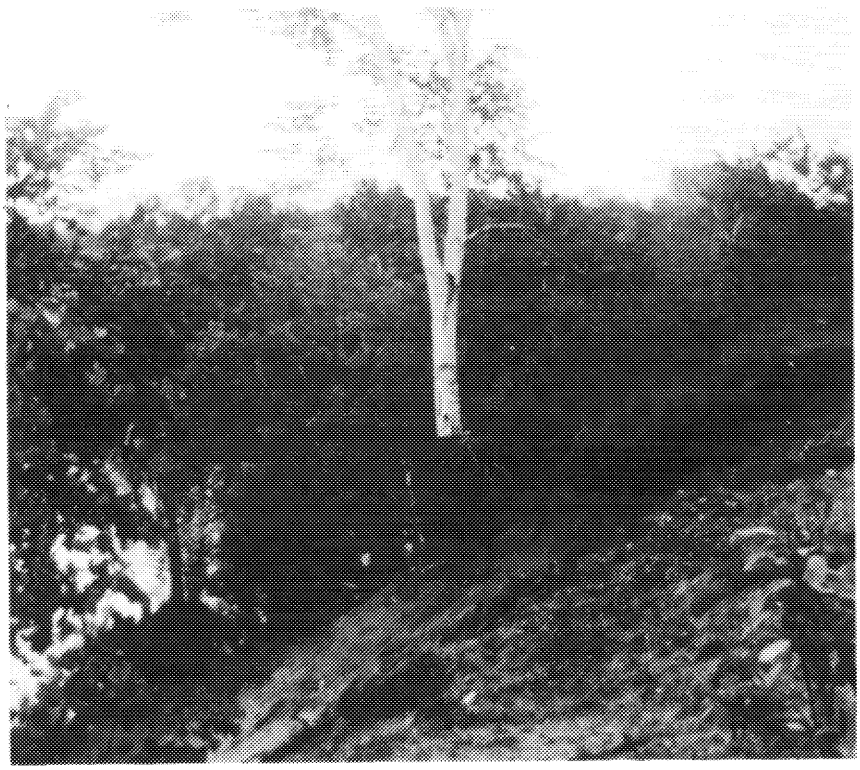
SHORE EROSION

10. The shore problems in Lake Memphremagog involve the erosion of beaches and banks, the loss of beach structures, fences, lawns and vegetation and the submergence of beaches and boathouse approaches. The greatest damage is found in the vicinity of Indian Point and Lindsay Beach where the length of shore affected at these localities is one mile and one and one-half miles, respectively. This frontage is exposed to storms from the north and northwest.

11. A reconnaissance of the area on 29 September 1953 disclosed that damage occurs mainly in the spring of the year after the ice break-up. The water level at that time is a few feet higher than normal lake level resulting in submergence of low shore front areas. The higher waves which reach the shore due to the increased water depth, supplemented by the scouring effect of the ice, cause considerable erosion and undercutting of banks. The shores affected are privately owned, and some owners have placed revetments along the bank to prevent such erosion. At localities where adequate revetments have been placed the erosion has been stopped. It appears that this is the only method by which the problem of bank erosion may be solved and such protection is usually accomplished by individual owners.

SUMMARY

12. Navigation on Lake Memphremagog is confined to pleasure boating. The lake is inaccessible from other navigable waterways. A



Shore erosion by wave and ice action at Indian Point.
Lake Memphremagog, Vermont. Subregion "C".

boat yard at Newport, Vermont, provides adequate facilities for the existing and prospective fleet. There is no existing Federal navigation project in the lake and none is considered necessary.

13. Shore erosion due to ice and wave action constitutes a problem along the lake. The shores affected are privately owned and revetment by private interests is the most feasible method of combating the erosion.

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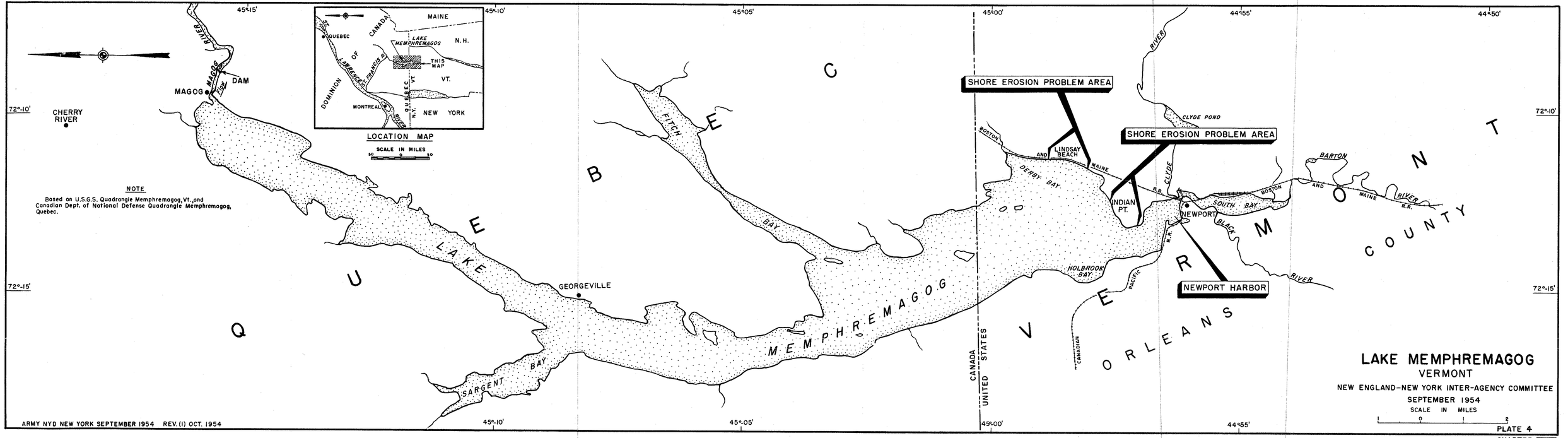
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MAGOG
MAGOG RIVER
DAM
CHERRY RIVER
GEORGEVILLE
LAKE MEMPHREMAGOG
FITCH BAY
SARGENT BAY
DERBY BAY
HOLBROOK BAY
SOUTH BAY
CLYDE POND
CLYDE RIVER
BLACK RIVER
INDIAN PT.
NEWPORT
NEWPORT HARBOR
SHORE EROSION PROBLEM AREA
SHORE EROSION PROBLEM AREA
LINDSAY BEACH AND BOSTON MAINE R.R.
BARTON AND BOSTON MAINE RIVER R.R.
PACIFIC R.R.
CANADIAN PACIFIC
CANADA
UNITED STATES
QUEBEC
VERMONT
ORLEANS COUNTY
LOCATION MAP
SCALE IN MILES
50 0 50
CANADA
MAINE
N.H.
VT.
NEW YORK
QUEBEC
LAKE MEMPHREMAGOG
THIS MAP
MONTREAL
DOMINION OF CANADA
LAWRENCE ST. FRANCIS R.
O.U.QUE.R.
N.Y.
VT.
NOTE
Based on U.S.G.S. Quadrangle Memphremagog, Vt., and Canadian Dept. of National Defense Quadrangle Memphremagog, Quebec.
LAKE MEMPHREMAGOG
VERMONT
NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
SEPTEMBER 1954
SCALE IN MILES
0 1 2
ARMY NYD NEW YORK SEPTEMBER 1954 REV.(1) OCT. 1954
PLATE 4
CHAPTER XXIX

SECTION III - NAVIGATION AND BEACH EROSION IN THE LAKE CHAMPLAIN DRAINAGE BASIN, NEW YORK AND VERMONT

GENERAL DESCRIPTION

1. Physical description. - Lake Champlain is located in the States of New York and Vermont, forming the boundary between these states, and extends 107 miles from Whitehall, New York, to Missisquoi Bay in Canada. (See Plates 5 to 9). Its greatest unobstructed width is 10 miles, opposite Burlington Harbor, Vermont. The lake contains about 80 islands, most of them in the northern portion, varying in size from about 30 square miles to a few square yards. The water surface area of the lake is 435 square miles and the shore line is more than 300 miles long. Almost two-thirds of the lake lies within the State of Vermont, one-third in the State of New York and about 17 square miles in Canada. For the purpose of description, Lake Champlain may be divided into three sections; the northerly section, extending from Missisquoi Bay in Canada for a distance of 35 miles south to Colchester Point; the central section, from Colchester Point 35 miles south to Crown Point, New York; and the southerly section, 37 miles long from Crown Point to Whitehall, known as the Narrows of Lake Champlain.

2. The northerly section of the lake is split into two bays of approximately equal width by Alburg Tongue, a peninsula jutting

out from the north, and a series of islands which are separated by straits. The westerly bay extends to Richelieu River, the only outlet of Lake Champlain. Widths of the bays vary from about 1 mile near the Canadian border to 6 miles just north of Colchester Point. Average depths in both bays increase from 10 feet in the north to over 100 feet in the southern portions. Highway and railroad bridges connect the large islands in this section of the lake with the mainland.

3. The widest and deepest areas in Lake Champlain are located in the central section. The unobstructed width is a maximum of 10 miles at Burlington Harbor decreasing to 1,500 feet at Crown Point. Average depths increase from 100 feet at Malletts Bay to over 200 feet opposite Essex, New York, and then decrease to 20 feet at Crown Point. The maximum depth of 400 feet is found just south of Essex Harbor.

4. The southerly section, known as the Narrows of Lake Champlain, is long and narrow with shallow depths. The width decreases gradually from 1,500 feet at Crown Point to 200 feet at Whitehall. The average depth decreases from 20 feet at Crown Point to 10 feet at Benson Landing, New York. From Benson Landing to Whitehall, marshes fill the lake except for a navigation channel 200 feet wide and 12 feet deep.

5. Tributaries. - Lake Champlain has many tributary streams. The principal tributaries draining into the lake in New York are

Great Chazy, Saranac, and Ausable Rivers from the west and Mettawee River from the east. In Vermont the principal tributaries are Missisquoi, Lamoille, Winooski and Poultney Rivers and Otter Creek all draining from the east. The only outlet is Richelieu River in Canada.

6. Connecting waterways. - Lake Champlain forms part of a series of inland navigable waterways which interconnect the St. Lawrence River, the Hudson River and the Great Lakes. Connection with St. Lawrence River is provided at the northern end of the lake through the Richelieu River and Chambly Canal. The Hudson River is reached from the southern end of the lake through the Champlain Canal. The Great Lakes are accessible through the Erie Canal, which links the Hudson River with Lake Erie, and through the Oswego Canal, which branches off the Erie Canal into Lake Ontario. The controlling depth of the waterways leading to the Hudson River and the Great Lakes is 12 feet and to the St. Lawrence River, 6.5 feet.

7. Geology. - The formation of the Lake Champlain area in its present physical character began during the late Tertiary Period. The land to the east of the present Champlain Lowland was folded into a rough resemblance to its present terrain. A trough was created at the foot of the Adirondacks, and through it flowed a river, probably southward into the ancient Hudson River. The glacial invasion during the Pleistocene Epoch overwhelmed the area, scoring the trough at the foot of the Adirondacks. As the ice sheet melted and withdrew, a body of water known as Lake Vermont was formed,

filling the lowlands between the Green and Adirondack Mountains, reaching past the headwaters of the present Lake Champlain at Whitehall and pouring into the Hudson River. Lake Vermont had begun to decrease in size before the lowland was wholly clear of ice, for the overflow during the late stages of the ice age was greater than the water furnished by the dwindling ice sheet.

8. The whole area has been depressed by the immense weight of ice it had borne. The ocean meanwhile had been swollen by a vast impouring of water from the glacial melting. When the ice sheet blocking the St. Lawrence River Valley finally melted away, salt water invaded the Champlain Lowland. The estuary thus created, Champlain Sea, extended as far south as Whitehall. Present Lake Champlain yields evidence of its oceanic past. Bones of seals, walruses and the skeleton of a whale have been found on its shores.

9. The earth rose as the weight of the ice sheet vanished, but its elevation was not uniform. The land lifted more rapidly just north of Lake Champlain, eventually raising the Richelieu River Valley above that of the St. Lawrence River. The newborn lake thus was cut off from immediate contact with the St. Lawrence River, except by connection through the Richelieu River. Streams draining into Lake Champlain have converted it to a fresh water lake.

10. Shore characteristics. - The shore line of Lake Champlain is over 300 miles long and is characterized by low shores of emerged deltas and jutting rock headlands which rise to elevations of about

1,000 feet above lake level. Beaches are generally narrow and many are completely submerged during high lake level. The northerly section of the lake contains many indentations, gently sloping beaches and rolling upland. The central section is bordered by steep bluffs and rugged terrain with narrow beaches and is less deeply indented. The southerly section is fronted by high ground varying from steep slopes to sheer bluffs.

11. Shore materials largely consist of sandy clay and boulder deposits of glacial origin. The high banks containing these materials are vulnerable to wave attack, wind and rain erosion and frost action. Parts of the shore having rock outcroppings offer some resistance to wave action. Extensive formations of black shale extend along the easterly shore of the lake. Outcrops of limestone and dolomite are common. Much of the shore consists of large deltas built from sediments deposited by tributary streams emptying into the lake.

12. Bridges. - Fourteen bridges cross various sections of Lake Champlain. A highway bridge at the northern end of the Narrows of Lake Champlain from Crown Point, New York to Chimney Point, Vermont and a highway bridge and a railroad bridge from Rouses Point, New York to Alburg Tongue, Vermont are the only bridges crossing the principal route of navigation through the lake. The location and description of each bridge are given in Table 4 .

13. Lake levels. - Mean low level in Lake Champlain is 93.0 feet above mean sea level. The level of the lake has varied from 0.6 feet below to 8.8 feet above low lake level. The lowest lake

Table 4 - Bridges crossing Lake Champlain, Subregion "C"

Location	Type	Use	Miles from Whitehall	Horizontal clearance (feet)	Vertical clearance (Feet above high lake level)
Rouses Point - Alburg	Swing	Highway	106.8	126.9	16.2 (1)
Rouses Point - Alburg (Rutland Railroad)	Swing	Railroad	106.6	89.3	5.7 (1)
East Alburg - Hog Island	Bascule	Highway	105.9	45.0	11.7 (1)
East Alburg - Hog Island (Central Vermont Railroad)	Swing	Railroad	105.6	36.9	4.9 (1)
Isle La Motto - Alburg Tongue	Swing	Highway	99.4	30.0	2.2 (1)
South Alburg - North Hero Island	Fixed	Highway	99.2	90.0	13.7
Alburg Tongue - North Hero Island (Rutland Railroad)	Swing	Railroad	95.7	77.0	4.0 (1)
South Hero Island - North Hero Island	Bascule	Highway	91.8	80.0	14.2 (1)
South Hero Island - North Hero Island(Rutland Railroad)	Swing	Railroad	90.1	80.0	3.9 (1)
South Hero Island - Milton	Fixed	Highway	82.6	33.3	10.6
South Hero Island-Colchester Point (Rutland Railroad)	Swing	Railroad	78.1	80.0	2.7 (1)
Crown Point - Chimney Point	Fixed	Highway	36.7	186.0	85.6
Whitehall, Route 22	Bascule	Highway	3.2	90.0	3.3 (1)
Whitehall (Delaware and Hudson Railroad)	Fixed	Railroad	2.5	97.2	6.2

(1) In closed position.

levels occur normally in September or October and the highest in April or May. The International Joint Commission, which has jurisdiction over boundary waters between the United States and Canada, by an order issued in 1937, has fixed the level of Lake Champlain between a maximum of 95.5 feet and a minimum of 93.0 feet (referred to mean sea level datum 1929 adjustment) in the navigation season from April through December and a minimum of 92.5 feet during the remainder of the year. The level would be regulated by a control dam located on Richelieu River, after excavation of the natural river bed controlling the lake level upstream from the dam. Ice conditions generally prevail in the lake between January and March, freezing to a thickness of as much as two feet during severe winters.

14. Prevailing winds and storms. - The prevailing winds are from the southwest and northwest. United States Weather Bureau records indicate that during the period April through November, winds over 19 miles per hour from these quadrants occur nearly 25 percent of the days in this period. These winds are of sufficient intensity to generate waves which adversely affect navigation and the shore. The direction of wave approach is modified by the irregular shore line and the many islands and peninsulas in the lake and there appears to be no general pattern of littoral drift for the entire area. The direction of drift varies at different locations. Severe storms to which the area is subject have been generally either of the transcontinental or cyclonic type in the late winter and spring, or of the hurricane type in the fall. Maximum wind velocities in excess of 50 miles per hour from the south have been recorded.

15. History. - The recorded history of Lake Champlain begins with its discovery in 1609 by the French explorer Samuel de Champlain. The lake was used by Indians for fishing and to move war parties to battle against other tribes. Later, when the French settled around Lake Champlain and in Canada and were threatened by hostile Indians, the first forts were built along the lake to serve as outposts. During the colonial struggle between France and England, which began in 1690, Lake Champlain played an important role. Expeditions from both groups navigated the lake in raids against the enemy. Significant campaigns were also waged around the lake during the Revolutionary War and the War of 1812. These were highlighted by naval battles. Benedict Arnold, in 1775, led the defense of Forts Ticonderoga and Crown Point with a small American fleet built on the lake at Whitehall. Eventually Burgoyne, the British general, surrendered to Arnold at Saratoga. During the War of 1812, Commodore Thomas Macdonough defeated the British fleet off Plattsburgh, thereby forcing the retreat of an invading British force from Canada.

16. Commercial navigation on Lake Champlain started during the last quarter of the 18th Century. The vessels engaged in trade were sailing craft of various types. Horses, beef, pork, lumber, potash, maple sugar, flax, ashes and iron were shipped north into Canada, and rum, gin, tea, coffee, chocolate, linens and woolens were exported

from Canada to New York and Vermont. In 1808, the "Vermont", the first steamboat launched on any lake, was built in Burlington Harbor, Vermont and used for transportation of cargo and passengers between ports on Lake Champlain and Canada. Steamboats were subsequently constructed at Vergennes, St. Albans and Shelburne, Vermont. These plied generally between St. Johns, Canada, and Whitehall, New York, with stops at other ports en route.

17. The first industry of the early settlers of the area was the manufacture of potash from the abundant forests which were being cleared. Soon agriculture became the principal occupation with the growing of wheat, corn, rye and buckwheat predominating and in the early 1840's dairying and sheep and cattle raising were introduced. Iron ore was extensively mined on the New York shores of the lake until about 1890 when competition of the ores of the Mesabi Range higher in iron content made it largely unprofitable. Port Henry alone continues as a mining center in the Lake Champlain area. It is estimated that more than 50,000,000 tons of ore have been taken from a bed near Port Henry that still appears inexhaustible. The ore was originally shipped south in Barges; at the present time it is moved by rail.

18. Investigations of deep waterways through Lake Champlain. - Various projects have been proposed and studied from time to time for a deep waterway from the St. Lawrence River to the Hudson River through Lake Champlain. The two most recent reports on the proposed

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waterways are described in the following paragraphs.

19. A resolution by the House Committee on Rivers and Harbors adopted 16 January 1935 authorized a review of reports on deep waterways between the Great Lakes and the Atlantic tide waters with a view to determining the advisability of constructing a waterway between Lake St. Francis on St. Lawrence River and Hudson River at Albany, by way of Lake Champlain. The Chief of Engineers in a report to the Secretary of War, dated 8 March 1938, concurred in the views and recommendations of the Board of Engineers for Rivers and Harbors that the cost of an adequate deep-draft waterway would exceed the prospective benefits and a detailed survey was not recommended.

20. On 6 January 1936, the Chief of Engineers assigned the District Engineer, First New York District, to assist the International Joint Commission in its investigation of a waterway from Montreal in Canada through Lake Champlain to connect with Hudson River. The Government of Canada designated two Canadian engineers to aid in the investigation. A report was submitted to the Commission on 15 March 1937 by the American and Canadian engineers containing estimates of costs of providing 12-foot, 14-foot and 27-foot deep waterways and benefits to be derived therefrom. It was concluded that the estimated benefits were not commensurate with the high costs of the work. (See also Chapter XXXVIII).

21. Tributary area. - The area immediately tributary to Lake Champlain consists of the Counties of Clinton, Essex, Franklin,

Warren and Washington in New York, and Addison, Chittenden, Franklin, Grand Isle and Rutland in Vermont. This area (9,272 square miles) had a 1950 census population of 381,104, a 4.6 percent increase since 1940. Agricultural activities in the area include dairying, raising of livestock, and growing potatoes, corn and other grains. Quarrying of granite, slate and marble is a leading industry. The leading items manufactured are food products, glass, and paper.

22. The principal activity on the lake for serving the tributary area consists of the receipt of petroleum products transported from New York Harbor and Albany in shallow-draft tankers and barges. Petroleum products are received at Burlington, Shelburne, and St. Albans in Vermont and Plattsburgh, Westport, Port Henry and Ticonderoga in New York and are distributed to the hinterland by rail and truck. Newsprint paper is shipped from Canada to New York Harbor via Lake Champlain. Fertilizer products and other commodities are shipped north along the same route. The shore is readily accessible by first class U. S. and State highways, and by the Delaware and Hudson, Rutland, and Central Vermont railroads.

23. Shore development. - The lake shore frontage is largely developed for recreational purposes and is occupied by numerous seasonally-used dwellings. The area is well-known as a year-round vacation resort providing excellent facilities for bathing, boating and fishing in the spring and summer, hunting in the fall, and for winter sports. There are 270 hotels and 290 tourist courts along

or near the lake for accommodation of vacationists. Four State parks have been established: Sand Bar State Forest Park and St. Albans Bay State Forest Park in Vermont, and Cumberland Bay Campsite and Crown Point Reservation and Campsite in New York. There are 20 small public bathing beaches. A United States military reservation fronts the lake south of Plattsburgh, New York. A part of the lake shore frontage is devoted to agriculture. Most of the shore is privately owned land.

24. Improvements for navigation. - Substantially all of the navigation improvements in Lake Champlain have been provided by the United States, with the exception of dredging of approaches and areas adjacent to wharves and pleasure boat facilities by State, municipal and private interests. The State of New York has constructed the New York State Barge Canal System which connects with Lake Champlain on the south, and the Canadian Government has improved Richelieu River which connects with Lake Champlain on the north.

25. Improvement for navigation of Lake Champlain by the United States was first authorized by the Act of 4 July 1836 and provided for the construction of breakwaters in Burlington and Plattsburgh Harbors and dredging in the Narrows of Lake Champlain at Whitehall and in the channel between North and South Hero Islands. Subsequent modification of the projects provided for lengthening of the breakwaters and for dredging of the inner harbor area at Plattsburgh and additional dredging in the Narrows of Lake Champlain and in the channel between North and South Hero Islands. Breakwaters were also constructed at Rouses

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Point, Swanton Harbor and Gordons Landing; dredging was performed in Great Chazy River, Port Henry Harbor, Ticonderoga River and Otter Creek; and boulders were removed from St. Albans Harbor. These latter improvements were authorized by River and Harbor Acts adopted in the period from 1872 to 1917. The total cost of existing projects in Lake Champlain to 30 June 1954 amounted to over $2,500,000; $1,850,000 for new work and $650,000 for maintenance. A list of existing projects in Lake Champlain, including dimensions and status of completion is shown in Table 5. Detailed descriptions of existing Federal projects are given later in this section. Existing navigation improvements are generally adequate for the needs of the present and immediately prospective commercial and pleasure boat traffic.

26. During the last 20 years studies for navigation improvements were authorized by Congress at four localities; at Rouses Point, New York; Burlington, Vermont; Otter Creek, Vermont; and the channel in the vicinity of Milton and South Hero, Vermont. Reports on the studies were submitted between 1936 and 1942 and all were unfavorable. A review of the report on the channel in the vicinity of Milton and South Hero, Vermont, was authorized in 1951. Details on the studies on individual waterways are presented below in this section.

Table 5 - Existing Federal navigation projects in Lake Champlain Subregion "C"

Project and description	Authorized dimensions: Depth (Feet at low lake level)	Authorized dimensions: Width (Feet)	Authorized dimensions: Length	Status
Rouses Point				
Breakwater	-	-	2,000 ft.	Completed
Great Chazy River				
Channel from mouth to Champlain Village	5	40	5.5 mi.	Completed
Plattsburgh Harbor				
a. Breakwater	-	-	1,565 ft.	Completed
b. Area between breakwater & wharves	9	27.5 acres		Completed
Port Henry Harbor				
Area along waterfront	12	500	3,000 ft.	Completed
Ticonderoga River				
Channel from mouth to Village of Ticonderoga	8	60-100	2.2 mi.	Dredging performed to project dimensions without protective works. Project considered incomplete.
Swanton Harbor				
Breakwater	-	-	1,900 ft.	Incomplete. Only 309 feet of breakwater constructed.
St. Albans Harbor				
Removal of boulders	6.5	Area of 34.4 acres cleared of boulders		Completed

Table 5 (continued)

Project and description	Authorized dimensions: Depth (Feet at low lake level)	Width (Feet)	Length	Status
Channel bet. North & South Hero Islands Channel	10	150	2,500 ft.	Completed
Gordons Landing Breakwater	-	-	800 ft.	Completed
Burlington Harbor Breakwater in 2 sections	-	-	6,000 ft.	4,157 feet of breakwater constructed. Project is considered completed.
Otter Creek				
a. Channel from mouth to Vergennes	8	100	8.0 mi.	Complete except for rock removal.
b. Basin at head of project	8	400	600 ft.	Completed
Narrows of Lake Champlain				
a. Channel from Whitehall to Benson Landing	12	200	13.5 mi.	Dredging performed only to width of 110-150 feet.
b. Install fender booms	-	-	-	Fender booms installed at 2 out of 5 points authorized. No fender booms needed at the other 3 points.

27. The State of New York has constructed the Barge Canal System which interconnects Lake Champlain, the Great Lakes and Hudson River. The Barge Canal System consists of the Erie Canal, 341 miles long with 35 locks extending from Waterford on the Hudson River to Buffalo on Lake Erie; the Champlain Canal, 60 miles long with 11 locks, extending from Waterford on Hudson River to Whitehall on Lake Champlain; the Oswego Canal, 24 miles long with 7 locks, extending from the Erie Canal at Three Rivers Point to Oswego on Lake Ontario; and the Cayuga and Seneca Canals, 93 miles long with 4 locks, extending from the Erie Canal to Ithaca on Cayuga Lake and Montour Falls on Seneca Lake. Controlling depth in the canals is 12 feet. Available length inside lock chambers is 300 feet and width, 44.5 feet.

28. The Canadian Government has constructed the Chambly Canal with 9 locks around the rapids in Richelieu River between St. Johns and Chambly, and a lock and dam at St. Ours, which permit navigation between Lake Champlain and St. Lawrence River. The controlling depth in the canal is 6.5 feet and minimum look dimensions are 118 by 22.5 feet.

29. Improvements for shore protection. - Portions of the shore in the vicinity of developed areas have been protected by bulkheads, seawalls and revetments constructed principally by private property owners. Some planting along the shore has been performed to protect farm land. There has been no Federal assistance authorized under Public Law 727, 79th Congress. The only Federal shore protection work in the area was authorized by the River and Harbor Act of

11 July 1870 as part of a navigation project, and provides for revetment of the beach in front of the United States military reservation at Plattsburgh. This work, which was designed to retain the shore material in order to reduce shoaling in the harbor, has not been undertaken as it is more economic to remove the material by dredging.

30. Terminal facilities. - A summary of terminal improvements by, States, municipalities and private interests is given below. More detailed information on terminal facilities for individual harbors is given later in this section.

31. There are 19 bulk oil storage plants located in 7 harbors on Lake Champlain. Eight of these storage plants are in Burlington, Vermont, 6 in Plattsburgh, New York, and one each in Westport, Port Henry and Ticonderoga in New York, and St. Albans and Shelburne in Vermont. The wharves connected with these plants have an aggregate berthage space of about 4,000 feet and depths alongside varying from 8 to 20 feet at low lake level. Mechanical handling facilities include pumps and pipe lines for the transfer of petroleum products from water carriers to storage tanks, which have a total capacity of over 115,000,000 gallons. Terminals constructed by the State of New York for barge canal commerce are located at Rouses Point, Plattsburgh, and Port Henry. Other commercial wharves constructed many years ago for handling iron ore and other cargo are no longer in use. The existing terminals are generally adequate for the present commerce.

32. Eight boat yards, two boat clubs, three marine service stations, and six pleasure boat landings are located on the lake.

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These have an aggregate berthage of 8,000 feet and depths alongside varying from 1 to 20 feet at low lake level. Marine railways, repair shops, fuel pumps, marine supplies and storage space for 300 boats indoors and 400 outdoors are available. The facilities are generally adequate for existing and immediately prospective pleasure boating needs.

33. Commerce. - The principal commercial activity on Lake Champlain consists of the receipt of petroleum products at various harbors for distribution by rail and tank truck to the hinterland. In 1952, the latest year for which commercial statistics are available, commerce on the lake amounted to 620,901 tons, of which 91 percent or 567,736 tons, consisted of petroleum products. This commodity is generally shipped from New York Harbor and Albany and is received at Plattsburgh, Westport, Port Henry and Ticonderoga on the New York side of the lake, and St. Albans, Burlington and Shelburne Bay in Vermont. The remaining 53,165 tons of commerce consisted of through shipment of 25,202 tons of newsprint paper south from Canada and 27,963 tons of clays, fertilizers and other commodities north from New York Harbor to Canada.

34. The volume and character of the commerce on Lake Champlain has changed considerably since the period when improvements were first provided. In the late 19th Century and the beginning of the 20th Century, commerce amounted to as much as 850,000 tons annually and consisted principally of shipments of lumber, woodpulp and iron ore from ports on Lake Champlain and receipts of coal and general cargo at these ports. The traffic gradually decreased until 1933, when

there were only 15,000 tons of commerce, and then rose to 460,000 tons in 1937 and remained relatively stable until World War II when it fell off considerably. Since the end of the war the commerce has generally increased. It reached 620,901 tons in 1952, and consisted almost entirely of the receipt of petroleum products received at ports on the lake. It is expected that the recent upward trend will continue in future years due to the increasing use of petroleum products in transportation, industry and home heating.

35. Five ferry routes cross Lake Champlain: Plattsburgh and Grand Isle; Port Kent and Burlington; Essex and Charlotte; Ticonderoga and Larabees Point; and Wright and Chipman Point. In 1952, more than 300,000 passengers and 110,000 automobiles were ferried across the lake.

36. Vessel traffic. - The principal classes of vessels navigating Lake Champlain are shallow-draft tankers, barges and dry cargo vessels, ferries, excursion steamers and various types of pleasure boats. In 1952 about 15,000 vessel trips, exclusive of pleasure boats were reported on Lake Champlain.

37. About 1,500 pleasure boats are based on the lake. They include 180 cruisers, 50 sailboats, 30 auxiliary sailboats, 190 inboards and about 1,000 outboards. Lengths vary from 12 to 75 feet and drafts from 0.5 to 8 feet. About 1,000 transient pleasure boats from points on the Atlantic seaboard as far south as Florida and Cuba, from ports on the Hudson River and the Great Lakes, from inland waterways of the Mississippi River system and Canadian waterways visit the lake annually and utilize its facilities.

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INDIVIDUAL HARBORS AND WATERWAYS

38. The following paragraphs present data on the principal harbors and waterways on Lake Champlain. These are considered in order from north to south in New York; then from north to south in Vermont. A brief description is given for each harbor and waterway; improvements for navigation, terminal facilities and commercial and pleasure boating activity are given where applicable.

ROUSES POINT HARBOR, NEW YORK

39. Description. - Rouses Point Harbor is situated on the west shore of Lake Champlain, about 1 mile south of the boundary line between the United States and Canada. (See Plates 6 and 10). The width of the lake near Rouses Point is about 1 mile. Depths in the harbor vary up to 9 feet at low lake level. The harbor is protected from storms by land formations on all sides except on the southerly side where a breakwater has been built by the United States. Traffic consists of commercial and pleasure boats bound to and from Canada. A U. S. customs inspection station is located in the harbor, where all vessels must be cleared. Local residents use the harbor for pleasure boating. The population of the Village of Rouses Point is 2,000. Agriculture is the leading occupation in the area.

40. Improvements for navigation. - All improvements for navigation in Rouses Point Harbor have been accomplished by the United States. The existing Federal project was adopted in 1885 and provides for a stone breakwater, 2,000 feet long, extending from

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Stony Point in a northeasterly direction to the 18-foot contour in Lake Champlain. Construction of the breakwater commenced in 1885 and was completed in 1893 at a cost of $98,468. No maintenance work has been performed to date.

41. Further improvements for the harbor have subsequently been requested and Corps of Engineers reports were made in 1915 and 1941. The more recent report was authorized by resolution of the House Committee on Rivers and Harbors adopted 18 October 1940. Local interests requested removal of shoals in the harbor, reconstruction of an abandoned dock, dredging of a basin with an approach channel, and installation of landing floats for seaplanes in or near the proposed basin. The Chief of Engineers in report to the Chairman, House Committee on Rivers and Harbors, dated 3 September 1941 concurred in the views of the Board of Engineers for Rivers and Harbors that the existing improvements in the harbor were adequate for the needs of navigation and that further improvements were not warranted.

42. Terminal facilities. - A solid fill pier in the harbor 600 feet long and 100 feet wide is used by United States customs for inspection of vessels bound to and from Canada. Another pier constructed by the State of New York for barge canal traffic providing 150 feet of berthage space is used at the present time as a pleasure boat landing. Another pier is used by a marine service station providing fuel and marine supplies for pleasure boats. A number of other terminals in the harbor are in poor condition and are not used.

43. Commerce. - There is no commercial activity in the harbor other than through shipments of Canadian newsprint paper to the Port of New York, and return shipments of fertilizer and miscellaneous commodities. In 1952, 53,165 tons of commerce passed Rouses Point Harbor in 802 trips of commercial vessels. The commerce during 1952 is typical of other years.

44. Pleasure boating. - Sixty-five boats are based in Rouses Point Harbor, consisting of 12 inboards and 53 outboards, with lengths from 12 to 22 feet and drafts of about 1 foot.

45. Discussion and conclusion. - Rouses Point Harbor was formerly used for the receipt and shipment of waterborne commerce. At the present time, the harbor is used only by through traffic and some local pleasure boats. Existing conditions in the harbor are considered adequate for present and prospective navigation.

GREAT CHAZY RIVER, NEW YORK

46. Description. - Great Chazy River is the northernmost tributary of Lake Champlain in New York State. (See Plates 6 and 11). The river has a total length of 23 miles; 5.5 miles of which are navigable. The navigable portion extends from Champlain Village to Lake Champlain and has a width of about 150 feet and depths varying from 1 to 5 feet. Only a few small pleasure boats navigate the river. The population in the area adjacent to the lower section of the river is about 2,000.

47. Improvements for navigation. - A Federal project for Great Chazy River was adopted in 1889 for a channel 5 feet deep and

40 feet wide, from a 5-foot contour in Lake Champlain to the Village of Champlain. The project was completed in 1895 at a cost of $18,000. Maintenance dredging has not been performed and the project channel has shoaled to a depth of one foot at some points.

48. Pleasure boating. - No commercial traffic has been reported on Great Chazy River since 1893 and none is anticipated in the near future. Seventeen pleasure boats, two small cruisers and 15 outboards, are based in the river.

49. Conclusion. -Great Chazy River, formerly used for water-borne commerce is currently used only by a few small pleasure boats. No change in existing navigation activity is anticipated.

PLATTSBURGH HARBOR, NEW YORK

50. Description. - Plattsburgh Harbor is located on the westerly shore of Cumberland Bay, an arm of Lake Champlain. (See Plates 7 and 12,). The harbor embraces about 3 miles of waterfront from Crab Island north to the head of the bay. Cumberland Bay is roughly rectangular in shape, with a length of 3 miles and a width of 2 miles. Depths range up to about 40 feet. The harbor is used for receipt of petroleum products by barge and for pleasure boating. Except for small portions which are protected by Federal and State breakwaters, the harbor is exposed to storms from the south and southeast. The harbor is served by the Delaware and Hudson Railroad. Plattsburgh, with a 1950 census population of 17,738, is the largest city in the New York portion of the Lake Champlain Drainage Basin

and contains one-half of the population of Clinton County. The population in the area of the lake is augmented during the summer by vacationists, mainly from other parts of New York State and from Canada. The leading industries in Plattsburgh are manufacturing of paper, metal products and machinery. A United States Air Force Base is currently under construction at Plattsburgh. This base will ultimately receive petroleum products at a wharf to be built for this purpose in the harbor.

51. Improvements for navigation. - A Federal project for Plattsburgh Harbor was adopted by the River and Harbor Act of 1836 and modified by the Acts of 1870, 1890 and 1910. It provides for a breakwater 1,565 feet long extending in a northeasterly direction approximately 1,100 feet from shore; for dredging to a depth of 9 feet at low lake level between the breakwater and the wharves; and for revetment of the beach in front of the United States reservation. The breakwater was completed in 1893 and the dredging in 1913. Revetment of the beach has not been undertaken as the material washed therefrom into the harbor can be readily and economically removed by dredging. The total cost of the project to 30 June 1954 was $300,867; about $198,000 for new work and $102,000 for maintenance.

52. A number of reports have been made by the Corps of Engineers on Plattsburgh Harbor, the latest of which was submitted in 1915 in compliance with the River and Harbor Act approved 4 March 1913. Local interests desired a channel connecting the wharves in the vicinity

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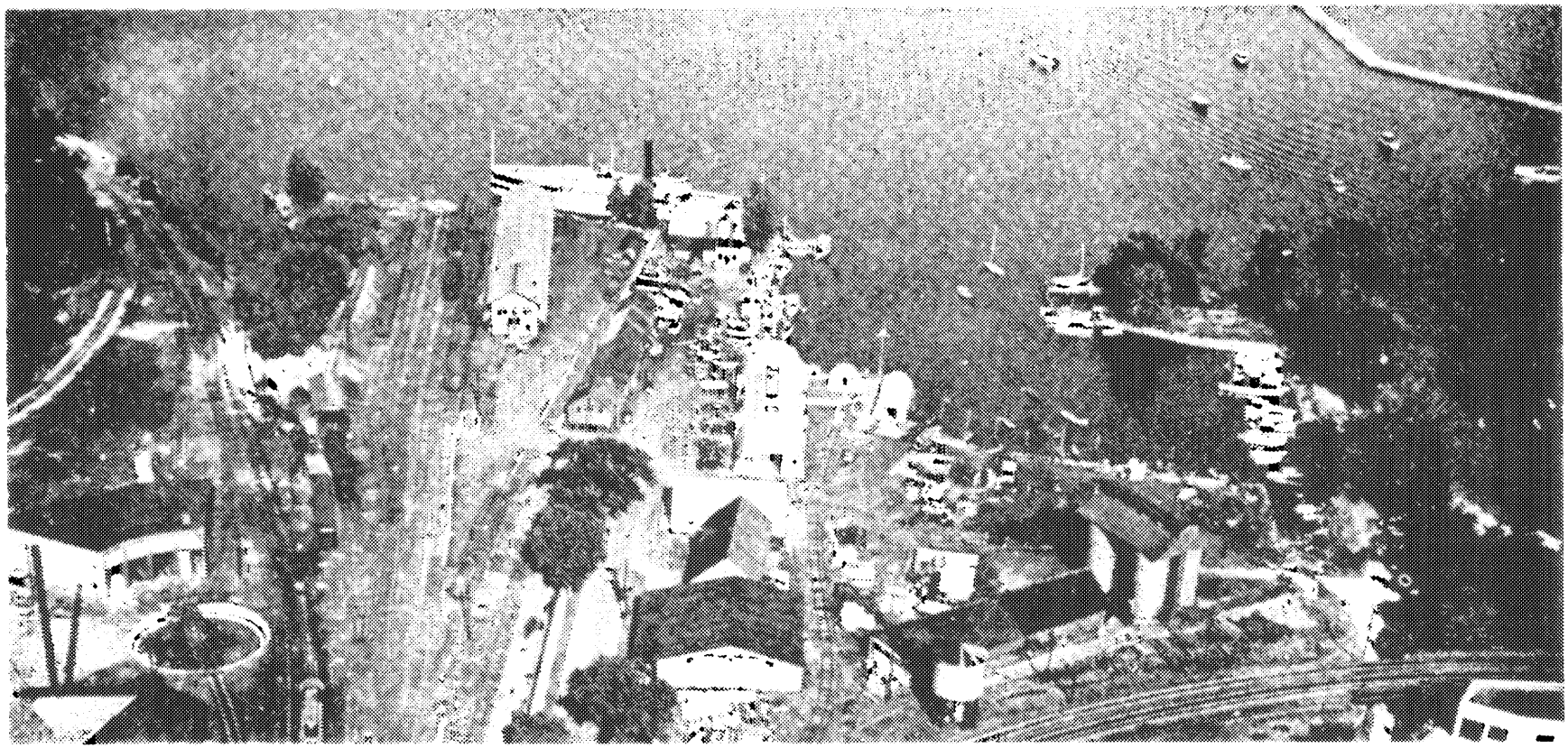

Boat basin on Lake Champlain at Plattsburgh Harbor, New York.
Protecting breakwater at upper right. Subregion "C".

of the mouth of the Saranac River with deep water in Cumberland Bay; extension of the existing Federal breakwater northward to protect the channel leading to the State Barge Canal Terminal; and building up of the island at the mouth of the Saranac River with spoil from harbor dredging. The Chief of Engineers in report to the Secretary of War dated 19 August 1915 concurred in the views of the Board of Engineers for Rivers and Harbors that the facilities already provided by the State and Federal Governments were adequate for existing and immediately prospective commerce, and further improvements was not advisable at that time.

53. Terminal facilities. - There are two commercial terminals in Plattsburgh Harbor. At the head of Cumberland Bay, about a mile north of the Federal breakwater, the State of New York has constructed a terminal for commerce of the Barge Canal System. The terminal consists of a solid fill pier with about 250 feet of usable berthage space and a basin, protected on the south side by an earth fill breakwater. Depths alongside the pier and in the basin average about 15 feet a low lake level. From the terminal, a dredged channel 150 feet wide and 12 feet deep extends to deep water in the bay. The terminal was constructed in 1913 at a cost of about $160,000. Adjacent to the terminal are located three oil companies receiving petroleum products by water from New York Harbor and Albany. Storage tanks of these companies have a total capacity of 12,500,000 gallons.

54. Three other oil companies utilize a terminal with available berthage space of 250 feet, located about 2 miles south of the

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Federal breakwater and their storage tanks have a total capacity of 12,520,000 gallons. The facilities behind the Federal breakwater are used solely by pleasure craft. These consist of about 25 acres of protected area 9 feet deep at low lake level used as an anchorage for pleasure boats, and a wharf with 270 feet of berthage space. Facilities for repair and servicing of boats are also available. This is the only pleasure boat terminal in the harbor and is located on property owned by the Dock and Coal Company which also owns near-by wharves with berthage space of 1,500 feet. However, these wharves have not been maintained in recent years and are not now usable. A ferry slip located at Cumberland Head, 5 miles east of Plattsburgh, is used by a ferry operating between this point and Gordons Landing, Vermont, on the opposite shore.

55. Commerce. - The total waterborne commerce in Plattsburgh Harbor in 1952 amounted to 185,464 tons. The tonnage during the last decade has averaged 84,935 annually, and has been increasing almost steadily since 1944, when the minimum tonnage of 33,525 was recorded. The commerce in former years included coal, iron ore, lumber and general merchandise, but between 1944 and 1954 consisted entirely of the receipt of petroleum products. Although the commerce is based on only one commodity, the tonnage in the past several years has been the largest ever recorded for Plattsburgh Harbor. The vessels engaged in this commerce are self-propelled tugs, and towed barges with loaded drafts from 8 to 12 feet. In 1952, 89 round trips were made to the harbor by these vessels. In addition 4,254 round trips

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were made by the ferry boats that operate from Cumberland Head.

56. Pleasure boating. - The local fleet of pleasure boats in Plattsburgh Harbor totals 55, consisting of 12 cruisers, 1 sailboat, 1 auxiliary sailboat, 6 inboards and 35 outboards. These range in length from 12 to 34 feet and have drafts from 0.5 to 6 feet. About 800 transient craft annually visit Plattsburgh.

57. Discussion and conclusion. - Plattsburgh is the largest harbor on the New York portion of Lake Champlain. Activity in the harbor is confined to receipt of petroleum products and pleasure boating. Local interests have made no request for improvement of the harbor in recent years. Existing facilities are considered adequate for the needs of present commercial traffic and pleasure boating and no improvements are necessary at this time. The increase in receipts of petroleum products in the harbor, primarily as a result of the construction of the Air Force Base at this locality, is expected to be met by construction of additional terminal facilities.

PORT KENT HARBOR, NEW YORK

58. Description. - Port Kent Harbor is located on the western shore of Lake Champlain opposite Burlington, Vermont. (See Plate 7). The harbor is exposed, except for an anchorage area of one acre behind a ferry wharf. Depths in the protected area range from 4 to 6 feet while depths in the nearby areas of the lake are as great as 300 feet. The harbor is used for ferry service to and from

Burlington and for pleasure boating. The latest report for improvement of Port Kent Harbor was made in 1834; no Federal projects have been authorized. The population of the village of Port Kent is 175 and of the neighboring village of Keeseville 2,000. The area is predominantly agricultural. Ausable Chasm, a natural rock gorge near the mouth of Ausable River and 3 miles from Port Kent, attracts many thousands of sightseers annually to this locality.

59. Terminal facilities. - A concrete and stone pier with a ferry slip is the only terminal in Port Kent Harbor. Alongside the pier there are also 6 slips and an anchorage area, 5 feet deep at low lake level, for accommodation of pleasure boats. Servicing facilities are available for small craft.

60. Commerce and pleasure boating. - In 1952, ferries made 1,916 round trips transporting 173,374 passengers and 60,017 automobiles between Port Kent and Burlington. These are the highest recorded since the start of World War II. Nineteen pleasure boats are based in the harbor, consisting of 1 cruiser, 4 inboards and 14 outboards, with lengths from 14 to 30 feet and drafts from 0.5 to 2.5 feet. About 100 transient craft annually visit the harbor.

61. Discussion and conclusion. - Existing navigation facilities in Port Kent Harbor are considered adequate for present and prospective traffic. No waterborne commerce other than that provided by ferry traffic is anticipated in the foreseeable future. Local interests have not requested any navigation improvements in

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recent years and none are considered necessary.

ESSEX HARBOR, NEW YORK

62. Description.-- Essex Harbor is located on the westerly shore of Lake Champlain, about 60 miles north of Whitehall, New York. (See Plate 8). Depths in the harbor range up to 12 feet with deep water in the adjacent sections of Lake Champlain ranging up to 400 feet. The harbor is exposed to storms from the east. The navigation activities are ferry service to Charlotte, Vermont, and pleasure boating. The village of Essex has a population of 525, which is considerably increased during the summer by vacationists and summer residents.

63. Terminal facilities. - The ferry slip has a depth of 8 feet at low lake level. There is also a boat yard in the harbor with 2 timber piers and a bulkhead forming a basin 160 feet long and 100 feet wide. The berthage space totals 500 feet with depths alongside varying from 6 to 13 feet at low lake level. The boat yard provides repairs, servicing, and winter storage space for 55 pleasure boats. A 5-acre anchorage area with an average depth of 10 feet is available in front of the boat yard.

64. Pleasure boating.-- Thirty pleasure boats, consisting of 12 cruisers, 3 sailboats, 7 inboards and 8 outboards are based in Essex Harbor. These have lengths from 14 to 42 feet and drafts from 0.5 to 4 feet. About 200 transient craft visit the harbor annually.

65. Discussion and conclusions. - A ferry terminal and a boat

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yard account for the boating activity in Essex Harbor. Existing facilities are adequate for present and prospective traffic. Improvement of the harbor has not been requested and is not considered necessary.

WESTPORT HARBOR, NEW YORK

66. Description. - Westport Harbor is located at the head of Northwest Bay, a 2-mile long and 1.5 mile wide indentation in the west shore of Lake Champlain 47 miles north of Whitehall, N.Y. (See Plate 8). The waterfront along Westport extends for about 1 mile along the bay. Depths within the bay range up to 150 feet and further offshore in the center of the lake outside the bay, depths increase to 250 feet. The harbor is exposed to storms from the easterly quadrant. Receipt of petroleum products and pleasure boating are the navigation activities. The population of the village of Westport is about 750 which is increased during the summer by vacationists and summer residents.

67. Terminal facilities. - An oil terminal and a boat yard are located in Westport Harbor. The oil terminal consists of a rock filled timber crib with dolphins 400 feet from shore for mooring of oil barges and a pipe line for transfer of petroleum products to storage tanks on the upland. There are 10 storage tanks with a total capacity of 4,500,000 gallons. The boat yard consists of a timber bulkhead with available berthage of 100 feet and depth alongside of 13 feet at low lake level. Facilities include a marine railway,

fuel pump, repair shop and a storage shed with a capacity of 12 boats. The outdoor storage capacity is 35 boats. An anchorage area 6 acres in extent and with depths from 20 to 25 feet, located adjacent to the boat yard is utilized by local and transient pleasure boats.

68. Commerce. - In 1952, 27,925 tons of petroleum products were received at the oil terminal, transported by self-propelled and towed tank barges in 19 round trips with drafts up to 11 feet. The volume of commerce has remained relatively stable since 1946 averaging about 25,000 tons annually.

69. Pleasure boating. - Seventy-four pleasure boats, consisting of 10 cruisers, 1 auxiliary sailboat, 18 inboards and 45 outboards, are based in Westport Harbor. These have lengths from 14 to 41 feet and drafts from 0.5 to 5 feet. About 500 transient craft visit the harbor annually.

70. Discussion and conclusion. - Commercial traffic in Westport Harbor consists of the receipt of petroleum products at an oil terminal. A boat yard provides repair and servicing facilities for local and transient pleasure boats. Conditions in the harbor are adequate for present and prospective traffic and navigation improvements are not considered necessary.

PORT HENRY HARBOR, NEW YORK

71. Description. - Port Henry Harbor is located on the western shore of Lake Champlain just north of the Narrows, and about 37 miles north of Whitehall, New York (See Plates 9 and 13). Lake Champlain

is 2 miles wide in this section with depths ranging up to 30 feet. Commercial and recreational boating interests utilize the harbor. The population of Port Henry is 1,830. Mining of iron ore is carried on extensivley in the adjacent area and Port Henry Harbor formerly was an important ore shipping center.

72. A Federal project at Port Henry Harbor was adopted by the River and Harbor Act of 8 August 1917 providing for dredging of an Area 3,000 feet long, 500 feet wide and 12 feet deep at low lake level in front of iron ore terminals located on the waterfront. The project was completed in 1919 at a cost of $79,406 including a contribution of $10,000 by local interests; $1,253 was expended for maintenance. The section of the harbor containing this improvement is not used at the present time due to diversion of the ore shipments from water to rail.

73. Terminal facilities. - The only commercial terminal in Port Henry Harbor in present use is owned by the State of New York and is used by an oil company for receipt of petroleum products. It consists of a pier 500 feet long and 75 feet wide with depth alongside of about 11 feet. Nine storage tanks are located near the pier with a total capacity of about 4,000,000 gallons. A boat yard with facilities for repair, service and storage of pleasure boats is located just north of the State terminal. The boat yard has a concrete wharf with berthage space of 150 feet and depth alongside of 12 feet. Two slips and an open water anchorage 20 feet deep and

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5 acres in extent are available for mooring small craft. The winter storage capacity is 35 boats indoors and about 100 outdoors.

74. Commerce. - Port Henry Harbor is located near an important iron ore mining center. Prior to construction of the existing porject about 35,000 tons of the more than 1,000,000 tons mined in the area annually were shipped by water; the remainder was shipped by rail. Upon initiation of construction of the project, in 1918, water shipments increased, until they reached over 110,000 tons in 1920. Water shipments were then discontinued for some years and have been made only sporadically since that time. During recent years the commerce has consisted entirely of petroleum products received from New York Harbor and Albany in tank barges with loaded drafts up to 10 feet. In 1952, receipts of 17,464 tons were made in 7 trips of these barges. The average annual commerce during the period 1946 to 1952 amounted to about 15,000 tons.

75. Pleasure boating. - The convenient location and the facilities available make Port Henry Harbor a stopping place for a large number of pleasure boats bound north and south through the Narrows of Lake Champlain. Approximately 600 of these craft visit the harbor annually. Thirty-seven pleasure boats are based in the harbor; 10 cruisers, 7 sailboats, 6 inboards and 14 outboards, with lengths up to 45 feet and drafts up to 5 feet.

76. Discussion and conclusion. - In former years Port Henry was an important shipping center for iron ore mined locally. The only waterborne commerce at present consists of the receipt of about

15,000 tons of petroleum products annually. A boat yard provides repair and servicing facilities for local and transient pleasure boats. Conditions in the harbor are adequate for present and prospective traffic and improvements to navigation are not considered necessary.

TICONDEROGA RIVER, NEW YORK

77. Description. - Ticonderoga River rises at the northern end of Lake George and flows in a northerly direction and then easterly into the Narrows of Lake Champlain near Ticonderoga, New York, as shown on Plates 9 and 14. The river is 3 miles long and in its upper mile falls 220 feet. This fall is utilized by 5 small hydro-electric plants. The navigable portion of the river containing a Federal channel extends from Lake Champlain 2.2 miles to the Village of Ticonderoga. Other than pleasure boating by a few local outboard motorboats, there is no navigation in the river. The Village of Ticonderoga has a population of 3,500. A large paper mill and a pencil manufacturing plant are located in the village. Thousands of visitors are attracted to the area because of its proximity to Lake George and Lake Champlain and by historical land marks, the most famous being Fort Ticonderoga, located at the mouth of the river overlooking the Narrows of Lake Champlain.

78. Improvements for navigation. - The Federal project for Ticonderoga River was adopted in 1881. It provides for a channel 8 feet deep and 100 feet wide from the 8-foot contour in Lake Champlain

to a railroad bridge near the mouth; thence, 8 feet deep and 60 feet wide to the Village of Ticonderoga. The length of the project is 2.2 miles. Dredging to project dimensions was completed in 1892 at a cost of $16,500. No maintenance has been performed, and the channel has shoaled to a present controlling depth of about 3 feet.

79. The River and Harbor Act of 13 June 1902 authorized a report on Ticonderoga River in accordance with requests by local interests for dredging to restore the channel to project dimensions. The Chief of Engineers in report to the Secretary of War dated 1 December 1903 concurred in the views of the Board of Engineers for Rivers and Harbors that an increase in depth was not needed by the canal boats which carried most of the commerce at that time and that only a small number of vessels would benefit, making it inadvisable for the United States to improve the river further.

80. Terminal facilities. - There are no commercial terminals or pleasure boat landings along Ticonderoga River. The only terminal in the area is located at Montcalm Landing, about 1 mile south of Ticonderoga River on Lake Champlain. Data on this terminal are given in the section of this report on the Narrows of Lake Champlain.

81. Discussion and conclusion. - Ticonderoga River is not used for waterborne commerce. A few small pleasure boats provide the only navigation on the river. Local interests have not requested navigation improvements in recent years and none are considered necessary.

SWANTON HARBOR, VERMONT

82. Description. - Swanton Harbor is located on the easterly shore of the northeastern bay of Lake Champlain, about 7 miles south of the Canadian border. (See Plate 6). Depths vary from 12 feet within 250 feet of the shore to 85 feet in the center of the bay. There are no commercial or pleasure boat facilities in the harbor. Occasional pleasure boating is the only navigation activity in the area. Commerce has not been reported in the harbor since 1889.

83. Improvements for navigation. - Swanton Harbor has been improved for navigation by provision of a breakwater by the Federal Government for protection to the harbor from storm waves from the southwest, the direction of greatest exposure. The project was authorized in 1873 providing for a breakwater 1,900 feet long extending from the shore in a northwesterly direction. Only 309 feet of the breakwater (submerged crib) were constructed at a cost of $70,500. Further construction was held up pending determination as to whether further expenditure of funds was warranted by the development of commerce. The development of commerce did not materialize and the work was not completed.

84. Discussion and conclusion. - Only occasional pleasure boating is carried on in Swanton Harbor. Commerce is not expected to develop in the foreseeable future. Local interests have not requested navigation improvements in recent years and none are considered necessary.

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85. Description. - St. Albans Harbor embraces an area of about 50 acres in the upper end of St. Albans Bay, a natural indentation in the northeastern shore of Lake Champlain. (See Plates 6 and 15). The harbor is 15 miles south of the Canadian border and 25 miles north of Burlington, Vermont. Depths range up to 22 feet. The harbor is exposed to storm waves from the southwest; surrounding high ground affording protection from other directions. Receipt of petroleum products and pleasure boating are the only navigation activities. The population of St. Albans is 8,500, which is augmented during the summer by vacationists. St. Albans Bay State Forest Park, containing a picnic area, a bathing beach and a boat landing in the harbor attracts thousands of visitors annually.

86. Improvements for navigation. - A Federal project for St. Albans Harbor was authorized in 1910 providing for the removal of boulders and other obstructions in the vicinity of wharves to a depth of 6.5 feet at low lake level. The project was completed in 1913 at a cost of $3,125 with subsequent work amounting to $385. A recent informal investigation was made in connection with the desire of local interests for further clearing of an area immediately adjacent to a proposed wharf. It was concluded that Federal participation in this improvement was not warranted.

87. Terminal facilities. - There are 2 wharves in St. Albans Harbor, one used for handling of petroleum products and the other for pleasure boating. The petroleum wharf is a stone filled timber

crib about 500 feet from shore with depth alongside of 15 feet for docking of oil barges unloading petroleum products at a bulk storage plant. Seven storage tanks are located on the upland with a total capacity of 1,700,000 gallons. The other wharf is a solid fill concrete pier constructed by the State of Vermont for public use in connection with the State park development. The wharf provides a berthage space of 900 feet with depth alongside of 6 feet.

88. Commerce and pleasure boating. - Oil barge traffic originating in Albany or the Port of New York is the only commercial navigation in St. Albans Harbor. In 1952, 6,408 tons of petroleum products were received in 9 trips by vessels with full loaded drafts ranging from 8 to 10 feet. The 1952 commerce is typical of other years. About 63 pleasure craft are based in or near the harbor consisting of 5 cruisers, 13 inboards and 45 outboards with lengths from 12 to 26 feet and drafts from 0.5 to 2 feet.

89. Discussion and conclusion. - St. Albans Harbor is used for receipt of a minor quantity of petroleum products and for pleasure boating activity. Conditions in the harbor are adequate for present and prospective traffic and further improvement is not considered necessary.

CHANNEL BETWEEN NORTH AND SOUTH HERO ISLANDS, VERMONT

90. Description. - North and South Hero Islands, the latter also known as Grand Isle, lie in the center of the northern section of Lake Champlain, and together with Alburg Tongue divide this

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section of the lake into two bays about 35 miles long. (See Plates 6 and 16.) The body of water, about 4 square miles in extent, between the islands, known as "The Gut", is surrounded by land on all sides except for narrow openings into the two bays. The openings have been deepened by the Federal Government to form navigable channels and are used by pleasure boats and barges navigating between the bays. A railroad bridge crosses the western end of "The Gut" and a highway bridge the eastern end. Both are drawbridges and have a least horizontal clearance of 80 feet and 3.9 feet vertical clearance above mean high lake level in closed positions. The population of North and South Hero Islands is about 1,700. Many vacationists frequent the summer camps and hotels which are located on both islands.

91. Improvements for navigation. - The Federal project for the channel between North and South Hero Islands was authorized in 1888 and provides for a channel 10 feet deep and 150 feet wide at both entrances. The project was completed in 1908 at a cost of $10,000. No maintenance has been necessary to date.

92. Commerce and pleasure boating. - Barges carrying petroleum products from Albany or the Port of New York and destined for St. Albans Harbor constitute the only commercial navigation through the channel between North and South Hero Islands. About 10 trips are made annually by these barges. Thirty pleasure boats are based in the area between the islands. These consist of 3 cruisers, 2 inboards and 25 outboards, with lengths up to 28 feet and drafts to 2 feet. Transient craft

bound to and from the northeast bay of Lake Champlain also utilize the channel.

93. Discussion and conclusion. - Only a minor amount of traffic of tank barges and pleasure boats navigate the channel between North and South Hero Islands. Conditions in the channel are adequate for present and prospective traffic.

GORDONS LANDING, VERMONT

94. Description. - The harbor at Gordons Landing is a small indentation in the westerly shore of South Hero Island opposite Plattsburgh, New York. (See Plate 7). Depths in the harbor range up to 15 feet at low lake level. A Federal breakwater affords protection from storm waves. Activities in the harbor consist of ferry service to and from Cumberland Head near Plattsburgh and occasional pleasure boating. About 4,000 trips carrying 180,000 passengers and 58,000 automobiles are made by the ferries annually.

95. Improvements for navigation. - The existing Federal breakwater, 800 feet long extending from the shore to the 16-foot contour in Lake Champlain, was authorized in 1887 and completed in 1891 at a cost of $34,750. No maintenance has been performed to date.

96. Discussion and conclusion. - Ferry service and occasional pleasure boating are the only activities at Gordons Landing. Protection from storms is afforded by a Federal breakwater. Local interests have not requested additional navigation improvements and none are considered necessary.

CHANNEL IN THE VICINITY OF MILTON AND SOUTH HERO, VERMONT

97. Description. - This channel is located about 12 miles north of Burlington, Vermont, between the east shore of Lake Champlain, near the Village of Milton, Vermont, and the southeast corner of South Hero Island (See Plate 7). The channel crosses a sand bar which extends from shore to shore at the southern end of a long narrow bay which is bounded on the east and north by the mainland and on the west by North and South Hero Islands. The Lamoille River, draining an area of 716 square miles in Vermont, empties about one mile south of the sand bar. A causeway known as Sand Bar Bridge has been constructed on fill over the sand bar and forms a section of U. S. Route 2. A masonry culvert has been provided at the center of the causeway to permit navigation. The culvert has a vertical clearance of 10.6 feet at high lake level and a horizontal clearance of 33.3 feet at this level. At low lake level, the horizontal clearance is narrowed to about 10 feet by the abutment foundations and riprap. The controlling depth in the channel is $\frac{1}{2}$ foot at low lake level.

98. Sand Bar Bridge is situated adjacent to the most highly developed area in Lake Champlain. Within 15 miles south and west of the bridge are located Burlington, the largest city on Lake Champlain, Mallette Bay, the leading pleasure boat area and Plattsburgh, the largest city in the New York portion of the Lake. (More detailed data on these localities are presented elsewhere in this section). The area is a noted vacation resort and has a permanent population of about 100,000, which is increased during the summer by thousands

of vacationists attracted by the excellent recreational facilities. The area north of Sand Bar Bridge, adjacent to the northeast bay is less developed. It has a total population of 15,000, the largest center being St. Albans with a population of 8,500.

99. Terminal facilities. - There are two pleasure boat landings near the channel at Sand Bar Bridge. These are located in the northeast bay on South Hero Island at the western end of Sand Bar Bridge. They provide servicing of boats, including minor repairs, and have winter storage capacity for about 75 boats. A protected anchorage, 5 acres in extent and 5 to 10 feet deep, is available adjacent to the landings. In Malletts Bay, Burlington Harbor and Plattsburgh Harbor, within 15 miles south and west of the channel, are located 6 boat yards and boat clubs. These provide servicing and repair facilities and have winter storage space for 350 pleasure boats. About 15 acres of protected anchorage area with depths up to 50 feet are available adjacent to the landings at these localities.

100. Pleasure boating. - The pleasure boats based at the two landings in the northeast bay total 46, consisting of 1 cruiser, 5 inboards and 40 outboards with lengths ranging from 12 to 24 feet and drafts from ½ to 2 feet. About 40 additional pleasure boats, mostly outboards, are based along nearby shores in the northeast bay at camps and dwellings, where a few small landings are available for private use. Within 15 miles south and west of Sand Bar Bridge are based about 600 of the 1500 pleasure boats in Lake Champlain. These include 100 cruisers, 25 sailboats, 20 auxiliary sailboats,

125 inboards and 330 outboards, with lengths ranging from 10 to 48 feet and drafts from ½ to 6 feet.

101. Investigations for navigation improvement. - An investigation with a view toward providing a navigable channel through the sand bar was authorized by the River and Harbor Act approved 30 August 1935. It was proposed to dredge a channel 6 feet deep at low lake level and 75 feet wide through the sand bar, narrowing to 45 feet through the present site of the culvert. The channel would be 3,400 feet long and would extend north and south of the culvert. The plan involved replacement of the existing culvert with a drawbridge having a horizontal clearance of 45 feet. The State of Vermont indicated its willingness to alter the culvert so that a horizontal clearance of 20 feet at low lake level would be available with no change in vertical clearance. The Chief of Engineers in report to the Secretary of War dated 1 March 1937 stated that the slight modification proposed by the State would not provide adequate clearance for the traffic expected to use the improvement and that the probable benefits to small boat navigation were incommensurate with the high cost of dredging the channel and altering the bridge. The project was therefore not recommended. In accordance with a request by local interests a review of the above report to determine whether any modification of the recommendations contained therein is advisable at this time was authorized by resolution adopted 12 September 1951 by the Senate Committee on Public Works.

102. Improvement desired. - At a public hearing held in Montpelier, Vermont, on 19 March 1952 before members of the New England-New York Inter-Agency Committee, local interests again requested dredging of the channel through the sand bar. It was maintained that provision of a passageway for pleasure boats would eliminate the necessity for navigating the circuitous route around South Hero Island in order to reach the northeast bay from the south, and would stimulate the development of the area. It was also stated that the proposed channel would facilitate patrol and rescue operations in the northeast bay for a U. S. Air Force crash boat and a Coast Guard rescue boat based in Burlington Harbor. Since the public hearing, the crash boat has been replaced by a helicopter by the Air Force.

103. Conditions in the northeast bay. - The northeast bay of Lake Champlain is an ideal place for hunting, fishing and pleasure boating. The bay is about 35 miles long and 1 to 6 miles wide and has depths ranging up to 160 feet. Numerous well-sheltered coves are available for anchorage of pleasure boats. Because of its narrow width, the bay is less subject to storm waves than wider section of the lake. Three routes are available for access to the northeast bay from the main body of the lake. The northernmost route is through the channel between Alburg Tongue and North Hero Island. This channel has a controlling depth of 12 feet at low lake level and is crossed by a swing railroad bridge and a fixed highway bridge. Minimum clearances through the bridges are 77 feet horizontally and 13.7 feet

vertically above high lake level. The middle route is through the channel between North Hero and South Hero Islands, known as "The Gut". The controlling depth in "The Gut" is 8 feet at low lake level for a width of 75 feet. Minimum clearances through the two bridges that cross this route, both with movable spans, are 80 feet horizontally and 3.9 feet vertically above high lake level in the closed position. The southern route is through the channel between South Hero Island and the Vermont mainland and includes Sand Bar channel. This route is crossed by the culvert spanning Sand Bar channel and a swing bridge connecting Colchester Point and Allen Point (See Plate 7). The controlling depth in Sand Bar channel and clearances through the culvert are given in paragraph 97. The horizontal clearance through the railroad bridge is 80 feet and the vertical clearance 2.7 feet above high lake level in the closed position. The controlling depth in the channel through the bridge is 7 feet at low lake level.

104. Navigation difficulties. - Passage through Sand Bar channel is difficult for the smaller type of boats and barred entirely for the larger boats. During periods of low lake level, which normally start at the beginning of August and last through the remainder of the summer and through the fall, the shallow depth over the sand bar permits rowboats only to navigate through the channel, and these have to be dragged across during times when the lake level is extremely low. During periods of high lake levels, the low vertical clearance of the culvert bars navigation for boats with cabins, masts or antennas, permitting small motor boats only to pass through.

Restrictive conditions at this location have existed for many years and have not materially changed since 1937, when the investigation referred to in paragraph 101 was made.

105. Plan of improvement. - It is considered that the most suitable plan of improvement for elimination of the navigation difficulties at Sand Bar channel is that proposed in the 1937 report (see par. 101). The plan consists of the dredging of a channel 3,400 feet long and 6 feet deep, with a width of 75 feet, except under the highway bridge where the width is to be 45 feet. To provide this width and the required greater vertical clearance, it would be necessary to replace the existing culvert with a suitable drawbridge.

106. Estimates of costs. - A hydrographic survey of the channel at Sand Bar Bridge was made in 1936 in connection with the survey report then under preparation. A reconnaissance of the area made in 1954 indicated that no changes of any significance in the condition of the channel have occurred since 1936. Based on this survey, it is estimated that the proposed plan of improvement would require dredging of a total of 60,000 cubic yards of material, composed entirely of sand and silt. The above quantity includes overdepth of one foot and side slopes of 1 on 3. The dredging would be performed by the hydraulic method with spoil disposed at nearby areas. The cost of the dredging and construction of a suitable drawbridge across the channel is estimated at $199,000 (1949 price levels). Annual charges would amount to $13,000, including cost of operation and maintenance. A breakdown of the costs is given in Table 6.

Table 6 - Estimates of costs

Item	Initial cost (a)	Annual charges		
		Interest and amortization	Operation and maintenance	Total
Channel dredging (hydraulic method)	$ 79,000	$2,800	$1,600	$ 4,400
Bridge construction	120,000	4,200	4,400	8,600
Totals	$199,000	$7,000	$6,000	$13,000

(a) Includes contingencies, engineering and overhead.

107. Estimates of benefits. - An adequate passage through the bar as provided under the plan of improvement previously described would result in reduction of travel distance of about 16 miles by boats navigating to the southern part of the northeast bay from points to the south through an improved Sand Bar channel instead of the circuitous route around South Hero Island. The number of boats which would use this longer route unless Sand Bar channel were improved is estimated at 150, including 120 boats presently using this route and an additional 30 boats to allow for the normal increase in sport fishing and boating in the area. These are larger types of sport fishing and pleasure boats, which cannot navigate the channel in its present condition, but which would make about 600 trips annually to or from the northeast bay around South Hero Island or through an improved channel. Savings resulting from use of the shorter route are computed on the basis of the cost of operation of these pleasure boats in navigating the additional 16 miles. The cost of operation includes running expenses such as gas and oil, and fixed costs, which are based on the rental received by owners

of equivalent types of for-hire boats. The running expenses are estimates at 20 cents per mile, or $3.20 per trip for the 16 miles. The time consumed in traveling the additional 16 miles is about 2 hours. The rental of a pleasure boat of the type under consideration is about $2.00 per hour, making the fixed cost for the additional 2 hours of travel time $4.00 per trip. Total savings would therefore be $7.20 per trip. The savings for the 600 trips would be $4,320, which is the total annual benefit of the improvement.

108. Use of Sand Bar channel if improved would also be made by an estimated 200 additional pleasure boats of various types some of which, on account of their small size, are able to navigate the channel in its present condition during part of the season and thus gain entrance to the southern part of the northeast bay. The remaining additional boats, which are of larger size, cannot use the channel at any time. All of these boats, either because of the hazards involved in navigating the exposed route around South Hero Island or because of the extra time and expense, make use of other nearby areas in Lake Champlain suitable for pleasure boating and sport fishing. Any benefits from future use of the channel, if improved, by these boats should not be credited to this channel, since it would merely represent a diversion from other areas.

109. The ratio of benefits to costs is 0.33, indicating that the proposed improvement is not economical.

110. Discussion and conclusion. - The channel between South Hero Island and Milton, Vermont, is the only entrance from the south

marine railways, winter storage space for 90 boats indoors and 200 boats outdoors, and repair and servicing facilities are also available.

115. Pleasure boating. - There is no commercial vessel traffic in Malletts Bay. The number of pleasure boats based in the bay are estimated at 380, consisting of 80 cruisers, 20 sailboats, 15 auxiliary sailboats, 85 inboards and 180 outboards motor boats with lengths ranging from 12 to 48 feet and drafts from $\frac{1}{2}$ to 5 feet. Only about 50 transient craft visit the harbor annually because of its location away from the main body of the lake.

116. Discussion and conclusion. - Malletts Bay is the most active pleasure boat harbor in Lake Champlain. Its development as a popular vacation spot has been aided by its proximity to the urban area of Burlington; and its natural deep water and sheltered location make for ideal conditions for pleasure boating. No navigation improvements are considered necessary in the bay and none have been requested by local interests. Passage to and from the northeastern section of the lake is obstructed by Sand Bar Bridge and culvert. (See par. 97).

BURLINGTON HARBOR, VERMONT

117. Description. - Burlington Harbor is a cresent shaped identation on the east shore of Lake Champlain 40 miles by water south of the Canadian border. (See Plates 7 and 17). The harbor extends for about three miles along the Burlington waterfront. A Federal breakwater affords protection from wind and wave action to the highly developed portion of the waterfront and to an area of about 100 acres between the

breakwater and the shore. Depths in the harbor range up to 30 feet.

118. Burlington, with a population of 33,000, is the largest city in the State of Vermont and the largest on Lake Champlain. Manufacturing of electrical products, kichen equipment, wood and metal products and maple syrup candies is the principal industry in the city. The harbor, situated adjacent to the business center, serves as a port for receipt of waterborne petroleum products which are distrubted by rail and truck in northern Vermont and parts of adjacent states. Ferries carrying vehicles and passengers operate from the harbor to Port Kent, N.Y., on the opposite shore of Lake Champlain. A. U. S. Coast Guard station and a U. S. Navy training center are located in the harbor. The harbor is also used for pleasure boating and fishing and it contains a public beach development and a park. Tracks of the Central Vermont and Rutland Railroads run along the entire length of the waterfront connecting with all the principal commercial wharves.

119. Improvements for navigation. - The Federal project for Burlington Harbor provides for a breakwater 6,000 feet long located in the center of the harbor parallel with and about 1000 feet from shore, to be in two sections, the northerly 500 feet separated from the southerly 5,500 feet by a gap 200 feet wide for the purpose of safety in entering the harbor during storms. The existing structure was completed in 1890 and is composed of stone filled timber cribs capped with stone and concrete to lengths of 364 and 3793 feet, these

58-b

Breakwater on Lake Champlain at Burlington Harbor, Vermont.
Subregion "C".

lengths having been considered sufficient at that time. The cost of the project to 30 June 1954 was ~~$982,138~~ 988,138, $706,414 for new work and $281,724 for maintenance. A recent inspection of the breakwater disclosed the need for extensive repairs. Capstones have been displaced and core stone washed out and a section has tilted to one side and is in danger of collapsing. Plans have been made to repair the breakwater.

120. Three reports on improvements for Burlington Harbor have been made by the Corps of Engineers subsequent to completion of the breakwater. The first report, to determine the need for repair of the breakwater and an estimate of the cost therefor, was submitted on 23 January 1901. The Chief of Engineers recommended repair of the breakwater at an estimated cost of $57,750. These repairs were subsequently made. The next report was submitted on 9 January 1908 and considered further improvement for navigation in Burlington Harbor. It was concluded that improvements other than the breakwater were not necessary at that time. The latest report on Burlington Harbor was authorized by Congress on 2 August 1939. Local interests desired the construction of a small-boat basin in the harbor. The Chief of Engineers in report to the House Committee on Rivers and Harbors dated 23 February 1942, stated that the anticipated benefits from the proposed improvement would be almost entirely local and the general benefits would be insufficient to warrant participation by the United States, and the proposed

project was not recommended.

121. Terminal facilities. - Terminal facilities in Burlington Harbor are provided by oil companies, ferry and pleasure boat interests and Federal and municipal agencies. There are 8 oil terminals in the harbor with facilities for receipt, storage and distribution of petroleum products. Most of the terminals have steel sheet pile rubble filled cribs and dolphins located up to 250 feet from shore in depths ranging from 12 to 15 feet at low lake level. Pipe lines connect the cribs to oil storage tanks on the upland. The storage tanks in Burlington have an aggregate capacity of 80,000,000 gallons of petroleum products.

122. The ferry terminal in the harbor has 2 ferry slips and a basin surrounded by a timber bulkhead. There is usable berthage space of 1,650 feet with depths alongside of about 15 feet at low lake level. The ferry slips are utilized by 3 ferries carrying passengers and vehicles between Burlington and Port Kent. Two other ferry boats operated by the same concern between Plattsburgh and Gordons Landing and one between Essex and Charlotte use Burlington as a home port for repairs and winter layup. The basin is utilized by local and transient pleasure boats. The ferry company maintains facilities for repair, servicing and winter storage of pleasure boats. Additional pleasure boat facilities are provided by a boat club located in the southern part of the harbor with members owning about 50 outboards. Landing space at the club is available at a wharf 400 feet long with depth alongside of about 1 foot at low lake level.

Two submerged rubble breakwaters afford protection from storm waves to pleasure boats moored at the wharf.

123. The City of Burlington owns 3 wharves in the harbor with a total berthage space of 1000 feet and depth alongside varying from 6 to 14 feet at low lake level. These wharves are located behind the breakwater and are used for tying up barges, tugs and pleasure boats, particularly during storm periods. The city plans to expand its pleasure boat facilities during 1954 by placing steel pontoons at one of the city wharves to form a boat basin and installing servicing facilities at a total cost of $20,000. The U. S. Coast Guard and the U. S. Naval Reserve Training Center utilize 2 wharves located near the center of the harbor. These wharves have a combined berthage of 500 feet and depths alongside varying from 5 to 8 feet at low lake level.

124. A number of private and publicly owned facilities which are not utilized in connection with navigation activities are also situated along the Burlington waterfront. These facilities are afforded protection from storm waves by the Federal breakwater; the only facilities located outside the protected area of the harbor being 5 of the 8 oil terminals and the boat club.

125. Commerce. - Commerce in Burlington Harbor formerly consisted of receipts of grain, lumber and coal. In recent years the commerce has consisted of petroleum products shipped by barge from New York Harbor and Albany to bulk storage terminals located along the waterfront in Burlington. These products are transshipped by rail and truck to points throughout northern Vermont and parts of adjacent states and consumed locally. In 1952, the latest year for

which data are available, 319,200 tons of petroleum products were received in barges which made 223 round trips. Commerce in the harbor has increased almost steadily since 1933, except during the years of World War II, when restrictions on shipment and consumption of petroleum products were in force. This commerce is expected to continue to increase in the future. In addition to the above, ferries transported 173,374 passengers and 60,017 automobiles in 1,900 round trips between Burlington and Port Kent Harbor, New York, during 1952. Ferry traffic has been increasing at a steady rate since initiation of complete reports in 1948, when only 79,000 passengers and 37,000 vehicles were carried.

126. Pleasure boating. - There are 131 pleasure boats, consisting of 6 cruisers, 20 inboards and 105 outboards, based in Burlington Harbor with lengths ranging from 10 to 30 feet and drafts from $\frac{1}{2}$ to 4 feet. About 500 transient craft from the Atlantic seaboard, Hudson River, the Great Lakes, Canada and other harbors on Lake Champlain visit the harbor annually.

127. Discussion and conclusion. - Burlington Harbor is the most important commercial harbor on Lake Champlain and is extensively used for commercial traffic and pleasure boating. A Federal breakwater completed in 1890 affords protection from storms to the central portion of the harbor. A report in 1939, in connection with desires of local interests for Federal construction of a basin for small boats, was unfavorable. The existing breakwater is considered adequate for present and prospective commercial traffic and pleasure boating

and further improvements in the harbor by the Federal Government do not appear to be warranted. However, the present deteriorated condition of the breakwater make it necessary that it be repaired in order that it continue to provide the necessary protection from storm wave action to the harbor. Local interests are presently expanding the terminal facilities in the harbor to meet the needs of the increasing commerce and pleasure boating.

SHELBURNE BAY, VERMONT

128. Description. - Shelburne Bay is located on the east shore of Lake Champlain about 2 miles south of Burlington, Vermont. (See Plate 8). It is generally rectangular in shape having a maximum length north and south of 3 miles, a maximum width of 1 3/4 miles and an area of about 3⅛ square miles. The bay is landlocked except for a 3500-foot wide entrance from the main body of Lake Champlain on the north side. Depths in Shelburne Bay vary from 12 feet within 200 feet of shore to over 100 feet just inside the entrance. The average depth is over 50 feet. The principal navigation activities in the bay are pleasure boating and the receipt of petroleum products at a newly constructed oil bulk plant.

129. Terminal facilities. - There are two wharves in Shelburne Bay; one is used by an oil company the other by a boat yard. The oil comapny wharf consists of two sheet steel pile rubble filled concrete capped cribs with depths alongside of 20 feet for docking of tank barges and pumping of petroleum products to storage tanks located

on the upland. The storage tanks have a total capacity of 1,680,000 gallons. The boat yard is situated on the westerly shore of the bay and has a pier with 170 feet of berthage space, in addition to 6 slips. Depths alongside range from 14 to 18 feet at low lake level. Facilities at the boat yard include three marine railways, fuel pumps, repair and construction shops and winter storage for 12 boats indoors and 50 outdoors.

130. Commerce. - Commercial traffic in Shelburne Bay commenced in the summer of 1953 when a national petroleum concern established a bulk plant and is receiving gasoline by barge for distribution by truck. It is expected that the receipts during the next several years will average about 5,500 tons annually and will probably increase in the future when expansion of the storage facilities now being planned are accomplished.

131. Pleasure boating. - Forty-two pleasure boats are based in Shelburne Bay consisting of 11 cruisers, 4 sailboats, 11 auxiliary sailboats, 3 inboards and 13 outboards with lengths from 14 to 75 feet and drafts from $\frac{1}{2}$ to 8 feet. About 50 transient craft visit the bay annually.

132. Discussion and conclusion. - Barges delivering gasoline to a bulk storage plant and pleasure boats based in a local boat yard account for most of navigation activity in Shelburne Bay. The bay is naturally deep and is sheltered from storm waves. Local interests have not requested navigation improvements and none are considered necessary.

133. Description. - Otter Creek empties into Lake Champlain on the east shore 18 miles south of Burlington. (See Plate 8). The navigable portion extends from the mouth to the falls in Vergennes, a distance of 8 miles. In former years Vergennes was a busy harbor where shipbuilding was carried on and it was a port of ~~all~~ call for steamboats plying between Lake Champlain and ports in Canada. There is no commercial navigation on Otter Creek at present and there are no usable terminals. Only 5 pleasure boats are based in the waterway, two cruisers and three inboards, and transient boats visit the waterway only occasionally. The population of Vergennes, the only populated center in the immediate locality, is 1750.

134. Improvements for navigation. - The creek has been improved for navigation by the Federal Government. The project authorized by the River and Harbor Act of 10 June 1872 and modified in 1882 and 1884, provides for a channel 8 feet deep at low lake level and 100 feet wide from Lake Champlain to the foot of the falls at Vergennes, and for a basin at Vergennes of the same depth. No work of improvement has been done since 1900 when the dredging was substantially completed, with the exception of the removal of two small rock areas. Although the channel has silted so that now the controlling depth is about 5 feet, it is adequate for existing navigation and no further improvement is anticipated. The cost of the project was $60,254, and $7,619 have been expended for maintenance, principally for clearing

of snags and debris.

135. Investigation for navigation improvements. - An investigation with a view to modifying the existing project by straightening the channel and providing a larger turning basin at the city dock in Vergennes as requested by local interests was authorized by the River and Harbor Act of 30 August 1935. The Chief of Engineers in report dated 26 March 1936 concurred in the views of the Board of Engineers for Rivers and Harbors that the enlargement of the channel would be of negligible value to commercial and pleasure boat navigation and further improvement was not recommended.

136. Discussion and conclusion. - Otter Creek, formerly used for waterborne commerce, is at present used only by a few pleasure boats. Conditions in the channel are adequate for this activity.

BASIN HARBOR, VERMONT

137. Basin Harbor is a small indentation in the east shore of Lake Champlain about 20 miles south of Burlington, Vermont. (See Plate 8). The harbor has an area of about 2 acres with depths ranging to 20 feet at low lake level. There are two wharves in the harbor with total berthage space of 200 feet and depths alongside varying from 5 to 15 feet at low lake level. These are used for mooring of pleasure boats principally of transient and summer visitors at the hotel and cottages overlooking the harbor, which is 5 miles west of the Village of Vergennes. Servicing facilities for the pleasure boats and marine supplies are available at the wharves. Twenty-four pleasure boats are based in the harbor, including 7 cruisers, 2 sailboats, 3 inboards,

and 12 outboards, and about 200 transient craft visit the harbor annually for short periods. No request for improvement in the harbor has been made and none is considered necessary.

NARROWS OF LAKE CHAMPLAIN, NEW YORK AND VERMONT

138. Description. - This waterway, 37 miles long, comprises the southern end of Lake Champlain extending from Whitehall to Crown Point, New York. (See Plates 9 and 18). Widths in the Narrows range from 200 feet near Whitehall to 1,500 feet near Crown Point. Depths range up to 30 feet, the controlling depth in the navigation channel being 12 feet at low lake level. The waterway is utilized by the extensive commercial and pleasure boat traffic to and from the main body of Lake Champlain.

139. Improvements for navigation. - The lower 13.5 miles of the Narrows has been improved for navigation by the United States. This improvement connects the Champlain Canal, a part of the New York State Barge Canal System, with deep water in the northern part of the Narrows of Lake Champlain. The natural channel through the reach under improvement was narrow and tortuous with a controlling depth of 9.5 feet. The first work of improvement consisted of the dredging of a channel in Whitehall Harbor in 1836. A project for deepening the entire lower section of the Narrows to 12 feet for a width of 100 to 200 feet and installation of timber fender booms to prevent collision of boats with the rocky shores at two points was adopted in 1886. The existing project, adopted in 1917 provided for a

channel 12 feet deep and 200 feet wide with fender booms at three additional points. The project has not been completed to authorized dimensions. The work remaining to be done consists of widening the channel throughout its length to the project width of 200 feet and the construction of fender booms at three points. Expenditures prior to adoption of the existing project in 1917 totaled $134,000. Expenditures of the existing projects to 30 June 1954 amounted to $854,686, $566,811 for new work and $287,875 for maintenance.

140. Terminal facilities. - Two oil terminal and a pleasure boat basin are located along the Narrows of Lake Champlain. The oil terminals are located at Whitehall and at Montcalm Landing, New York, and consist of concrete cribs and dolphins with depths alongside of 12 feet at low lake level, and connected by pipe lines to storage tanks on shore. There are 8 storage tanks at Whitehall with total capacity of 2,000,000 gallons, and 7 storage tanks at Montcalm Landing with capacity of 600,000 gallons. The boat basin is located at Chipman Point, Vermont, 18 miles north of Whitehall. It has a timber pier and floats with 900 feet of berthage space and depths alongside ranging from 10 to 20 feet at low lake level. Servicing, repair and guest facilities are available.

141. Commerce. - Only a small volume of commerce in Lake Champlain terminates along the Narrows, at Whitehall and Montcalm Landing, the remainder passing on to ports on the lake and to Canada. In 1952, the latest year for which commercial statistics are available, a total of 620,901 tons of commerce were reported consisting

of 13,909 tons received at Whitehall and 606,992 tons of through traffic including that at Montcalm Landing. All of the commerce for Whitehall and 91 percent of the remaining commerce consisted of petroleum products shipped from New York Harbor and Albany and received at various harbors on Lake Champlain. Five percent of the through traffic, or 31,737 tons, consisted of fertilizer materials, clays and earths shipped north to Canada, and 4 percent or 25,200 tons consisted of newsprint paper shipped from Canada to the Port of New York. The total commerce reported for the waterway has generally been increasing. Since 1946 the increase has been over 75 percent. The vessels carrying this commerce are shallow-draft tankers and barges with drafts up to 12 feet. About 700 round trips were reported by these vessels in 1952.

142. Pleasure boating. - A fleet of 36 pleasure boats is based in the Narrows of Lake Champlain, consisting of 10 cruisers and 26 outboards. These have lengths from 12 to 47 feet and drafts from $\frac{1}{2}$ to $4\frac{1}{2}$ feet. About 800 transient craft bound to and from Lake Champlain navigate the waterway during the boating season. Many of these stop for service or overnight stay at Chipmans Point, where the only marina in the Narrows is located.

143. Discussion and conclusion. - The Narrows of Lake Champlain provide access to the principal harbors in Lake Champlain and Canada from Champlain Canal and Hudson River for commercial and pleasure boat traffic. A Federal project provides for a channel through the Narrows 12 feet deep and 200 feet wide. The completed portion of the improvement

is adequate for present and prospective navigation activity. Further improvement is not deemed necessary at the present time.

INDIVIDUAL SITES - BEACH EROSION

144. Introduction. - Shore erosion problems affecting both public and private property have been reported by local interests at 6 locations along the shore of Lake Champlain. These are (1) Rouses Point, New York, (2) Cumberland Bay Campsite, New York, (3) St. Albans Bay State Forest Park, Vermont, (4) Sand Bar State Forest Park, Vermont, (5) Burlington, Vermont and (6) Addison County, Vermont. A field reconnaissance was made on 15 and 16 June 1954 to determine the nature of these problems and the measures that have been taken and that are desired by the affected interests for protection of shore front property. The locations of the problem areas are shown on Plates 6 to 9. Details are given in the following paragraphs.

145. Rouses Point, New York. - The Village of Rouses Point is located on the west shore of Lake Champlain about 1 mile south of the boundary between the United States and Canada. (See Plate 6). Its shore is about 2 miles long and is largely occupied by wharves and residences. New York State Highway 9B passes through the village and fronts the lake for a length about one-half mile.

146. The erosion problem area adjoins the one-half mile section of the State Highway. Local interests report that the bank on which the highway is constructed has receded over 10 feet in the past 25 years as a result of wave action. Inspection of the area

Shore erosion on Lake Champlain at Rouses Point, New York, causing recession of the bank. Subregion "C".

revealed that sections of the highway are about 5 feet from the top of the eroded bank. The strip of land lakeward of the road is all privately owned and some property owners have dumped riprap to protect the shore. In places where adequate protection is provided erosion has been arrested. It was reported that the State of New York is considering placing riprap at locations where the highway is being threatened. Local interests indicated a desire for Federal or State assistance in the construction of stone revetment to protect the bank along the entire problem area.

147. The principal cause of erosion is wave action generated by storms from the northeasterly and southeasterly quadrants. Protection from southeast storms is generally afforded by the Federal breakwater off Stony Point (See paragraph 40) except during periods of extreme high lake level when it is overtopped. Severest damage occurs in the spring of the year when the depth of water immediately adjacent to the problem area is normally about 7 feet. Due to the absence of a protective beach, the waves break directly against the bank which is composed of sandy clay and small stones. The problem consist in the stabilization of the bank A solution appears to be the construction of an adequate revetment, possibly supplemented by creation of a protective beach in front of the structure.

148. In February 1947, the Village of Rouses Point requested Federal assistance in developing erosion control measures. The District Engineer, New York District advised the village of the

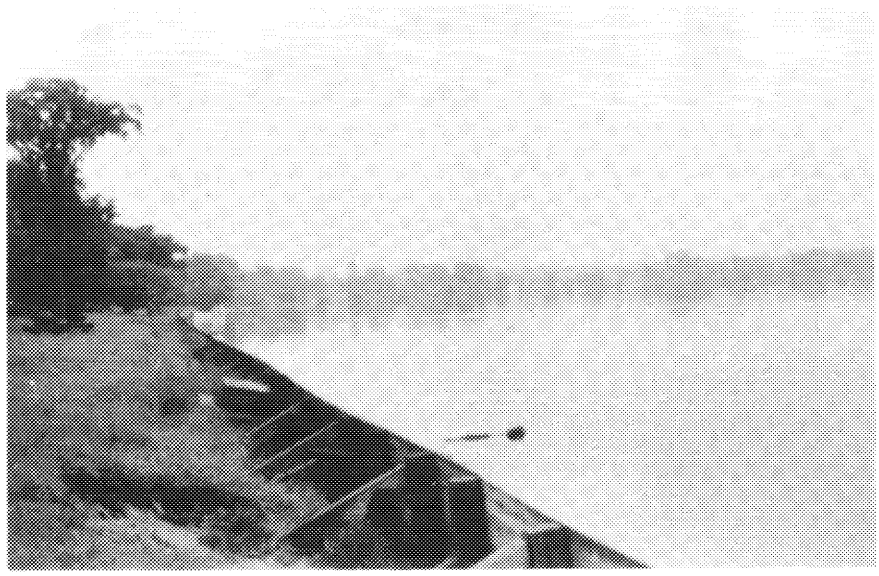
the procedures that may be followed to initiate a cooperative erosion study which might lead to Federal assistance under existing law. No action has been taken by the village to initiate a study.

149. Cumberland Bay Campsite, New York. - The Cumberland Bay Campsite, a public recreation area operated by the Conservation Department of the State of New York, is located on Cumberland Bay in the vicinity of Plattsburgh, New York. (See Plate 7). It is popular for picnicing and camping and has an attendance of about 225,000 per season, mostly Canadians. There is a great demand for recreational facilities in this area and it is reported that large numbers of visitors are turned away during peak periods.

150. The site occupies a frontage of approximately 1,500 feet facing deep water in Lake Champlain to the southeast. The fetch in this direction is about 8 miles and depths at low lake level range from over 200 feet in the center of the lake to about 6 feet near shore where a narrow beach adjoins the campsite. During high lake level in the spring of the year most of the beach is submerged exposing a bank composed of fine sand to direct wave attack.

151. In order to protect the shore the State of New York has constructed a timber bulkhead over 1,000 feet long. The structure has been effective in reducing erosion. However, considerable material from behind the bulkhead has eroded through the construction joints, due to the wash from breaking waves. The provision of an impervious structure would be required to remedy this condition.

152. Another problem reported at this location deals with



Shore protection works on Lake Champlain at Cumberland Bay Campsite, New York. Subregion "C".

the loss of beach due to wind erosion. Large quantities of fine sand are blown ashore covering roadways and campsites. Clearing of the area is performed periodically and the sand is dumped back on the beach. As a remedial measure sand fences have been installed. However, they are often destroyed by ice and wave action and require rebuilding frequently.

153. Other shore erosion problems exist on private property in the immediate area. Several concrete walls have been constructed by property owners to retard erosion.

154. A reconnaissance was made of the near by shore at the United State military reservation in Plattsburgh. Inspection disclosed that most of the shore is fronted by a narrow beach of small stones and boulders and that several ledge rock outcrops afford protection against erosion. A portion of the steep bank adjacent to the railroad has been adequately riprapped. No erosion problems were found in the area.

155. St. Albans Bay State Forest Park, Vermont. - St. Albans Bay State Forest Park, a public recreation area operated by the Vermont Forest Service, is located at the upper end of St. Albans Bay which is an indentation on the east shore of Lake Champlain about 15 miles south of the boundary between the United States and Canada. (See Plate 6). Facilities in the park include a bath house, bathing beach and picnic area. The frontage contains some 2,000 feet facing the lake to the southwest.

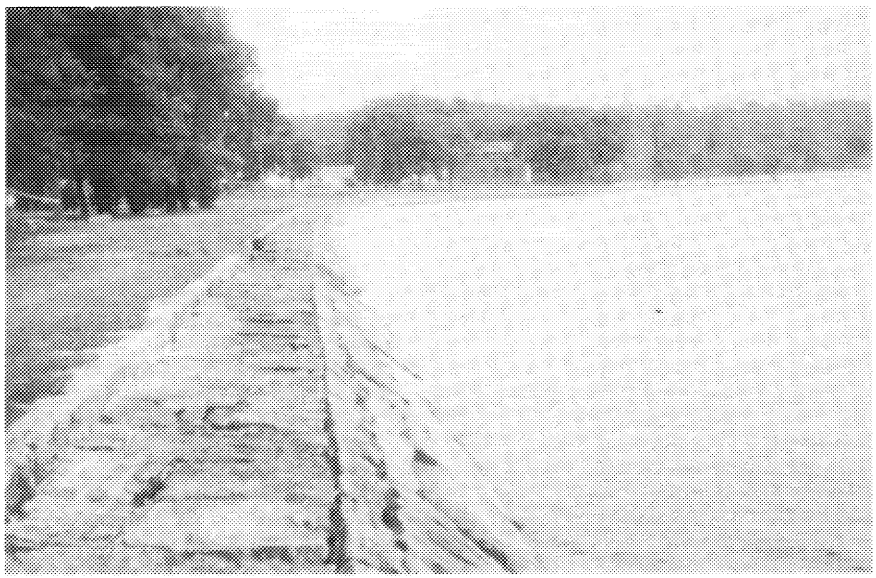
156. A substantial stone revetment constructed by the Civilian Conservation Corps protects the park shore for practically its entire length. The adjoining beach located at the westerly end is between 25 and 50 feet wide at low lake level. It is reported that much of the easterly portion of the beach has eroded and that there has been some accretion to the west. At high lake level the entire beach is submerged and waves generated by southwest storms break directly against the revetment. This causes the shore material behind the revetment to wash through the voids in the structure eroding the upland. The eroded areas have recently been filled with crushed stone.

157. Sand Bar State Forest Park, Vermont. - Sand Bar State Forest Park, a public recreation area operated by the Vermont Forest Service, is located on the east shore of Lake Champlain about 15 miles north of Burlington. (See Plate 7). Park facilities include a bath house, bathing beach, picnic and camping areas. The frontage along the lake has a length of about 2,000 feet. It is exposed to northerly storms.

158. About 500 feet of shore front is affected by erosion. Recession of the shore line of 3 feet in the past 2 years is reported. A stone footwalk is in danger of being undermined if erosion continues. The State of Vermont has recently dumped small stone at some locations to protect the shore. It was indicated that placing of additional stone was being considered.

159. Burlington, Vermont. - The City of Burlington is located

66-b



Protection works on Lake Champlain to reduce shore erosion.
St. Albans Bay State Park, Vermont. Subregion "C".

on the east shore of Lake Champlain about 20 miles southeast of Plattsburgh, New York. (See Plate 7). The shore, about 4 miles in length, is a half-moon shaped indentation facing the lake on the west where the depths increase to over 100 feet one mile from shore. Numerous wharves and a municipal bathing beach occupy the lake frontage which is largely privately owned. A Federal breakwater (see paragraph 119) affords protection to the middle 4,000 feet of the shore.

160. The areas north and south of the breakwater are exposed to storms from the northwesterly and southeasterly quadrants and a number of works have been provided to protect the shore against wave action. The Rutland Railroad has dumped considerable riprap where its tracks run close to shore. Waterfront property owners have constructed stone revetments and steel bulkheads to arrest erosion. Where works have been constructed, they appear to be effective in holding the shore. Local interests report that the bank near the south end of the city has receded some 200 feet in about 50 years due to wave action. Some of this land has recently been reclaimed by filling and protected by stone revetment.

161. Addison County, Vermont. - Addison County is located in the western part of Vermont. (See Plates 8 and 9). It fronts Lake Champlain for a distance of about 45 miles. Practically all of the shore is occupied by privately owned farm land.

162. At a public hearing held in Montpelier, Vermont, on 19 March 1952, a representative of the Addison County Production

and Marketing Administration Committee submitted testimony indicating a need for protection from erosion for an estimated 200,000 feet of lake shore. A desire for Federal aid in protecting the shore was indicated.

163. The problem area is predominatly composed of sandy clay banks which are easily eroded. Erosion by wave action generally occurs during periods of high lake level in the spring of the year when the soil is soft and highly saturated with water. This action is supplemented by the scouring effect of ice which undercuts the banks. Data obtained from the Soil Conservation Service of the United States Department of Agriculture reveals that about 90,000 feet of shore length has undergone severe erosion. It is reported that in the most severely eroded areas the shore line has receded some 600 feet in a period of about 50 years. About 50,000 feet of shore has been moderately eroded and 60,000 feet has been slightly eroded. The value of farm property in this area is placed between $25 and $75 per acre.

164. Protective measures taken against erosion have included the planting of shrubs on the banks in order to bind the soil. This has not proved successful in stopping erosion. It appears that stone revetment of the banks would provide effective protection. The cost of such work would be extremely high.

165. Under the Agricultural Conservation Program of the United States Department of Agriculture provision is made to assist land owners and operators to attain soil conservation objectives. The

Erosion of agricultural land bordering Lake Champlain, Addison County, Vermont. Subregion "C".

program consists of research, education, technical assistance, cost-sharing and such indirect aids as credit. Measures for shore protection by revetments are included in the program whereby the Federal Government would share in the cost of the work up to a maximum of 50 percent. Due to the extremely high cost involved in providing stone revetment, it is considered doubtful whether this work would be undertaken.

DISCUSSION AND CONCLUSION

166. Navigation. - Lake Champlain is an important commercial waterway and a noted pleasure boating area. The lake is accessible through improved connecting waterways with controlling depths of 12 feet from New York Harbor and the Great Lakes, and with controlling depth of 6.5 feet from Canada. Commercial navigation consists primarily of the transportation of petroleum products in shallow-draft tankers and barges from New York Harbor to various harbors in the lake. Burlington and Plattsburgh are the principal commercial harbors on the Vermont and New York shores respectively. Federal navigation improvements consisting of access channels, deepening of harbor areas and breakwaters have been provided at 12 locations on the lake. At 6 of these locations, there has been no commercial activity during recent years. The improvements at the remaining locations are adequate for present and prospective needs. Traffic of petroleum products is steadily increasing. A number of oil companies are presently expanding their terminal facilities in anticipation of a greater volume of business in the near future.

8

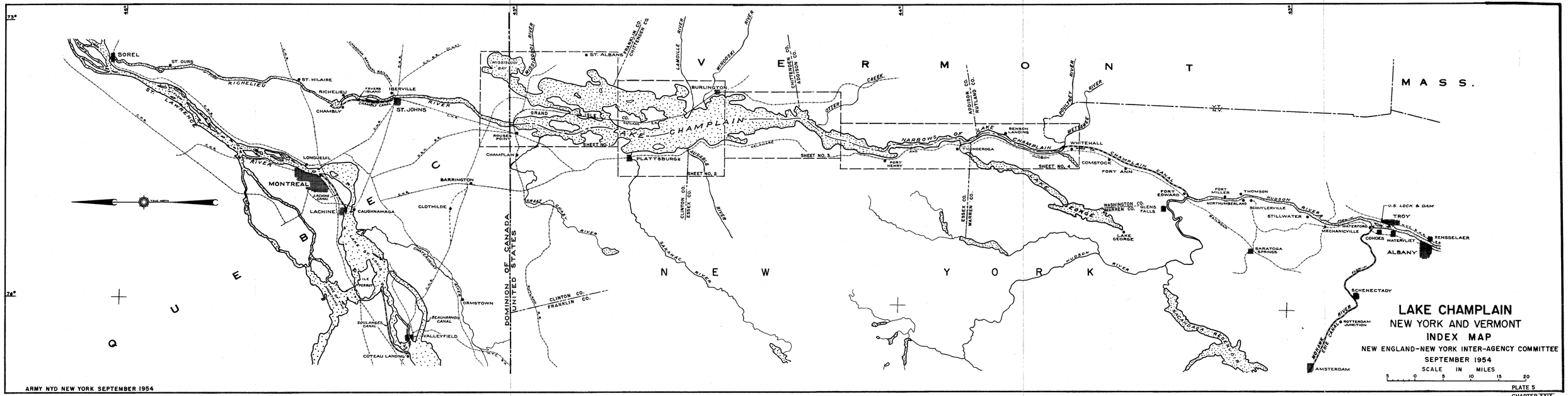
167. Pleasure boating activity on Lake Champlain is also increasing. At the present time, about 1500 pleasure boats are based in the lake and about 1000 transients visit the lake annually. Adequate natural and Federally-improved harbors are available for accommodation of these boats. Local interests have constructed landings and have provided facilities for servicing, repair and storage of pleasure boats. The need for additional facilities is being met, particularly at Burlington, where the city is planning to construct a marina for transient craft. A proposal was made by local interests for deepening by the Federal Government of the channel in the vicinity of Milton and South Hero, Vermont. It was determined that the improvement was economically infeasible.

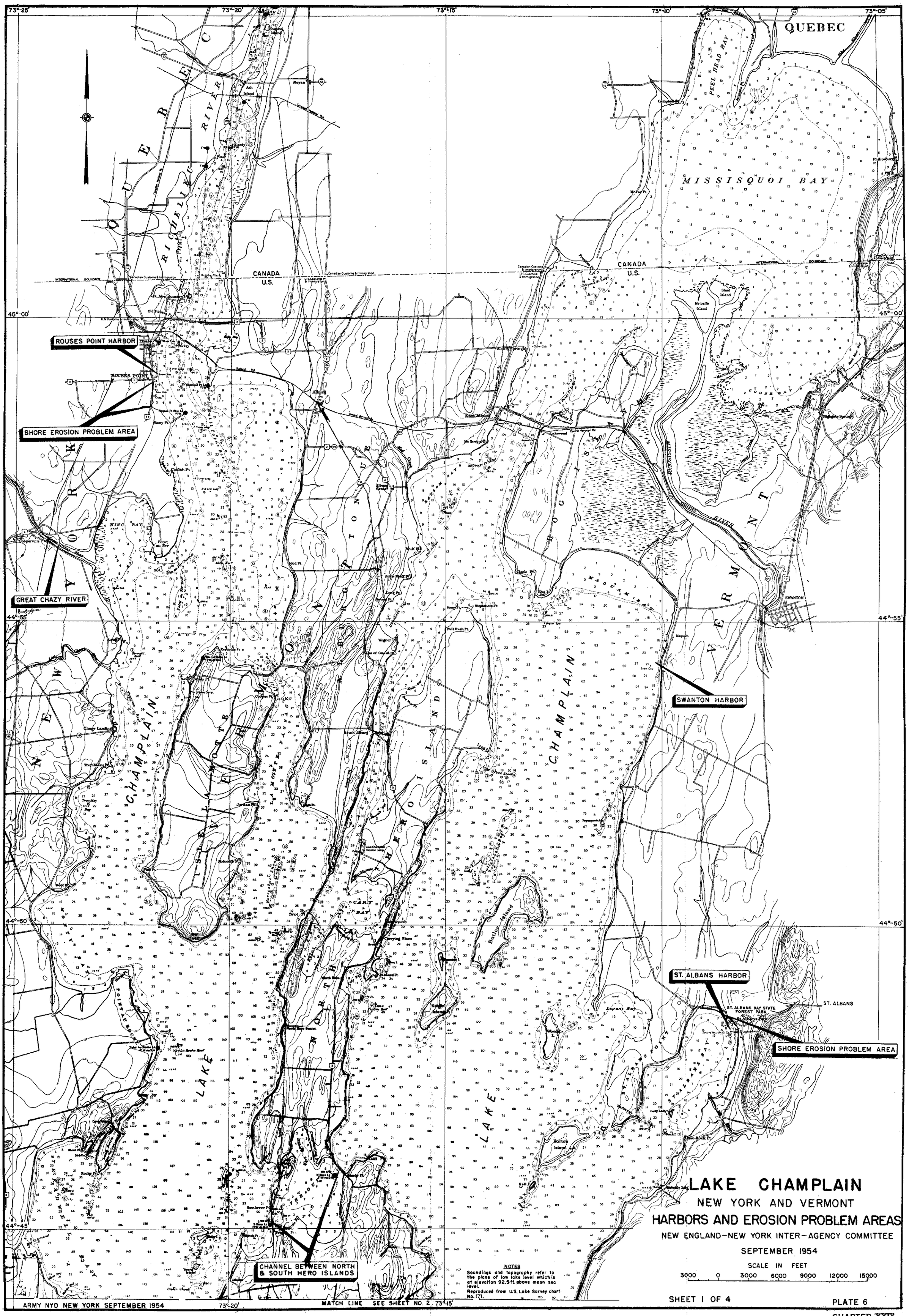
168. Shore erosion. - Erosion damages along the shores of Lake Champlain result from the loss of land. This occurs mainly in the spring of the year when the water level is a few feet higher than normal lake level and the material along the shore is highly saturated with water. The higher waves which reach the shore due to the increased water depth, supplemented by the scouring effect of the ice, cause erosion and undercutting of banks. The most serious erosion problem exists in Addison County, Vermont. The high cost of protecting the shore at this location makes the construction of protective works not feasible.

169. No storm wave damage to buildings or other property has been reported. This is attributed to the fact that most of the shore development in exposed areas is sufficiently distant from the lake to be outside the range of direct wave attack. At many locations

where highways and railroads are subject to wave action, stone protection has been provided and proved effective in arresting erosion.

170. There are no known erosion problems involving Federal property. It appears unlikely that local interests at any of the erosion problem areas will make application for a cooperative erosion study under the provisions of Section 2 of Public Law 520, 71st Congress, approved 3 July 1930, as amended and supplemented.


LAKE CHAMPLAIN
NEW YORK AND VERMONT
INDEX MAP
NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
SEPTEMBER 1954
SCALE IN MILES
5 0 5 10 15 20
PLATE 5
CHAPTER XXIX
ARMY NYD NEW YORK SEPTEMBER 1954
QUEBEC
NEW YORK
VERMONT
MASS.
DOMINION OF CANADA
UNITED STATES
LAKE CHAMPLAIN
SOREL
ST. OURS
ST. HILAIRE
RICHELIEU
CHAMBLY
IBERVILLE
ST. JOHNS
ST. LAWRENCE RIVER
LONGUEUIL
MONTREAL
LACHINE
CAUGHNAWAGA
BARRINGTON
CLOTHILDE
ORMSTOWN
VALLEYFIELD
COTEAU LANDING
BEAUHARNOIS CANAL
SOULANGES CANAL
LAKE ST. FRANCIS
ST. ALBANS
MISSISQUOI BAY
ROUSES POINT
CHAMPLAIN
GRAND ISLE
BURLINGTON
PLATTSBURGH
SARANAC RIVER
CLINTON CO.
FRANKLIN CO.
ESSEX CO.
CHITTENDEN CO.
ADDISON CO.
RUTLAND CO.
WARREN CO.
WASHINGTON CO.
NARROWS OF LAKE CHAMPLAIN
TICONDEROGA
PORT HENRY
LAKE GEORGE
GLENS FALLS
FORT EDWARD
WHITEHALL
COMSTOCK
FORT ANN
BENSON LANDING
CHAMPLAIN CANAL
HUDSON RIVER
FORT MILLER
THOMSON
NORTHUMBERLAND
SCHUYLERVILLE
STILLWATER
SARATOGA SPRINGS
MECHANICVILLE
WATERFORD
COHOES
WATERVLIET
TROY
ALBANY
RENSSELAER
U.S. LOCK & DAM
SCHENECTADY
ROTTERDAM JUNCTION
MOHAWK RIVER
AMSTERDAM
SCHOHARIE RESERVOIR
SHEET NO. 1
SHEET NO. 2
SHEET NO. 3
SHEET NO. 4



LAKE CHAMPLAIN
NEW YORK AND VERMONT
HARBORS AND EROSION PROBLEM AREAS

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE

SEPTEMBER 1954

SCALE IN FEET

3000 0 3000 6000 9000 12000 15000

NOTES

Soundings and topography refer to the plane of low lake level which is at elevation 92.5 ft. above mean sea level.
Reproduced from U.S. Lake Survey chart No. 171.

SHEET 1 OF 4

PLATE 6

CHAPTER XXIX

73°-25'
73°-20'
73°-15'
73°-10'
44°-40'
44°-35'
44°-30'
40°-30'

SHORE EROSION PROBLEM AREA

MATCH LINE SEE SHEET NO. 1

PLATTSBURGH

PLATTSBURGH HARBOR

GORDONS LANDING

PROPOSED CHANNEL, VICINITY OF MILTON AND SOUTH HERO

SHORE EROSION PROBLEM AREA

MILTON

MALLETTS BAY

PORT KENT HARBOR

SHORE EROSION PROBLEM AREA

BURLINGTON HARBOR

MATCH LINE SEE SHEET NO. 3

CUMBERLAND BAY

CUMBERLAND HEAD

VALCOUR ISLAND

SOUTH HERO

COLCHESTER

KEESEVILLE

WINOOSKI

BURLINGTON

NEW YORK

VERMONT

LAKE CHAMPLAIN

LAKE CHAMPLAIN

NEW YORK AND VERMONT

HARBORS AND EROSION PROBLEM AREAS

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE

SEPTEMBER 1954

SCALE IN FEET

3000 0 3000 6000 9000 12000 15000

NOTES

Soundings and topography refer to the plane of low lake level which is at elevation 92.5 ft. above mean sea level.

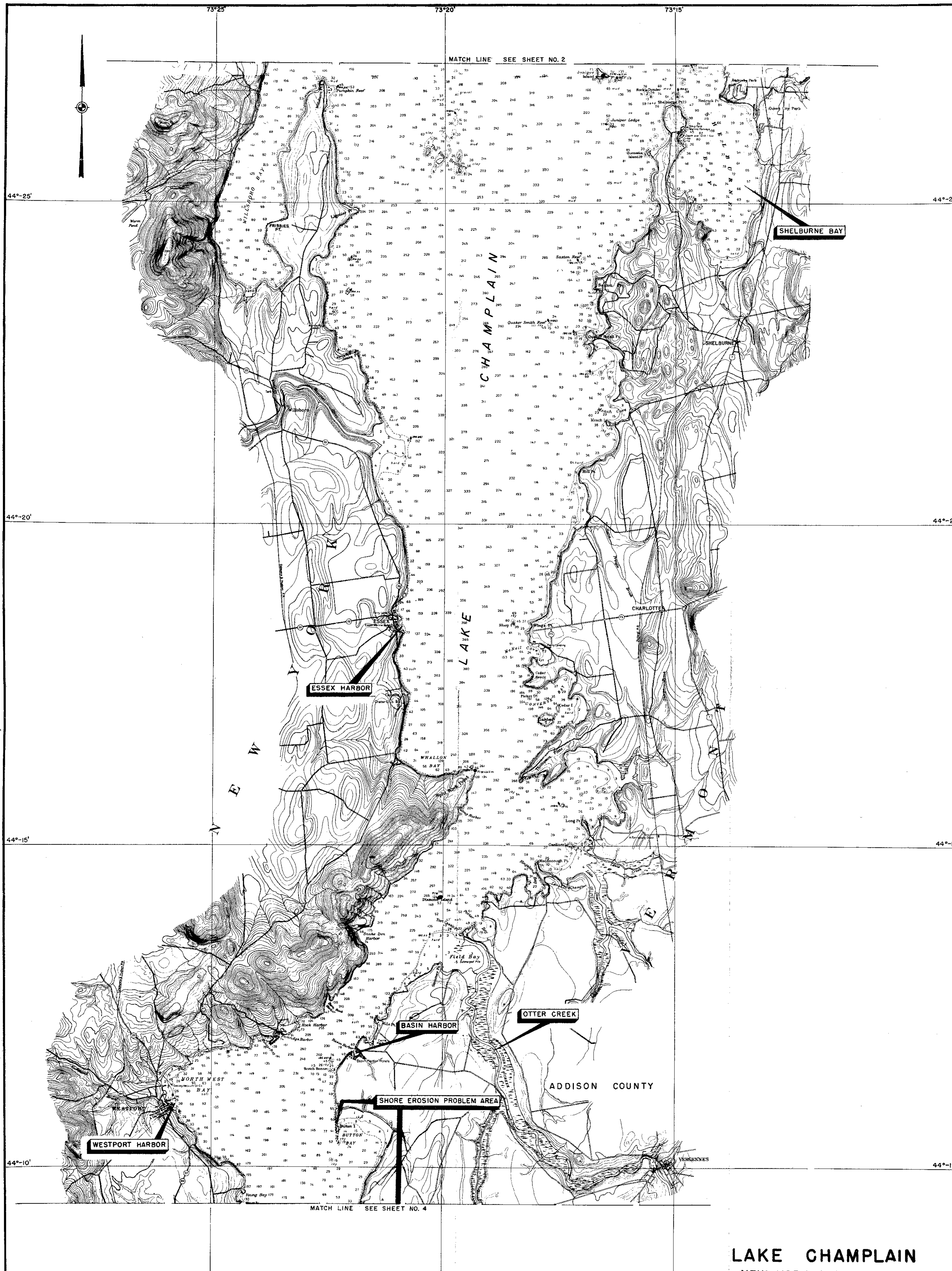
Reproduced from U.S. Lake Survey chart No. 172

ARMY NYD NEW YORK SEPTEMBER 1954

SHEET 2 OF 4

PLATE 7

CHAPTER XXIX



LAKE CHAMPLAIN

NEW YORK AND VERMONT

HARBORS AND EROSION PROBLEM AREAS

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE

SEPTEMBER 1954

SCALE IN FEET

3000 0 3000 6000 9000 12,000 15,000

NOTES

Soundings and topography refer to the plane of low lake level which is at elevation 92.5 ft. above mean sea level.

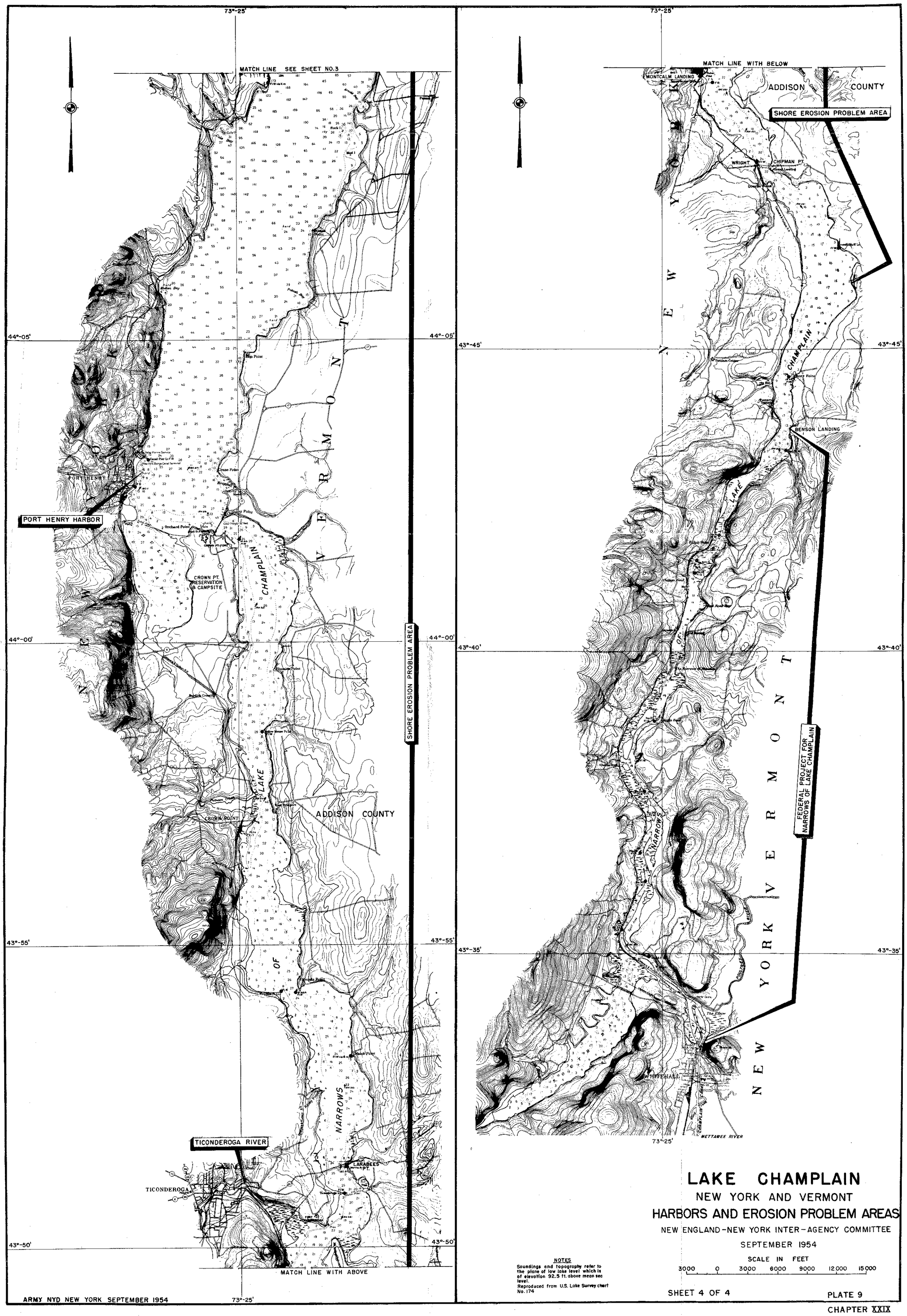
Reproduced from U.S. Lake Survey chart No. 173.

ARMY NYD NEW YORK SEPTEMBER 1954 73°-25' 73°-20' 73°-15'

SHEET 3 OF 4

PLATE 8

CHAPTER XXIX



ARMY NYD NEW YORK SEPTEMBER 1954

LAKE CHAMPLAIN

NEW YORK AND VERMONT

HARBORS AND EROSION PROBLEM AREAS

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE

SEPTEMBER 1954

SCALE IN FEET

3000 0 3000 6000 9000 12000 15000

NOTES

Soundings and topography refer to the plane of low lake level which is of elevation 92.5 ft. above mean sea level.

Reproduced from U.S. Lake Survey chart No. 174

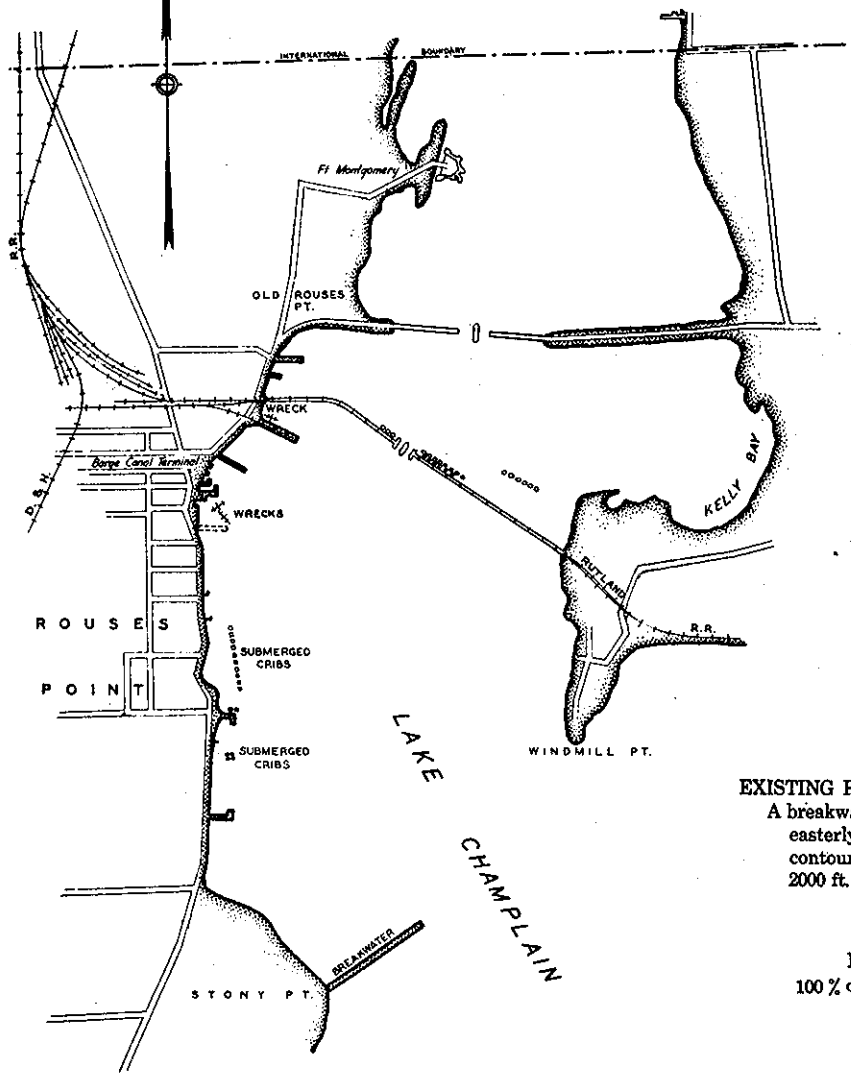
SHEET 4 OF 4

PLATE 9

CHAPTER XXIX

LAKE LEVEL VARIATION

MEAN LAKE LEVEL	+2.63 FT. L.L.L.
EXTREME HIGH LEVEL	+6.6 FT. L.L.L.
EXTREME LOW LEVEL	−0.6 FT. L.L.L.
MEAN ANNUAL VARIATION	5.8 FT.



EXISTING PROJECT (adopted 1885) provides for:
A breakwater extending from Stony Point northeasterly toward Windmill Point to the 18 foot contour in Lake Champlain, a total length of 2000 ft.

PROGRESS TO DATE
100 % of existing project completed.

ROUSES POINT (LAKE CHAMPLAIN), N. Y.
CONDITION OF IMPROVEMENT

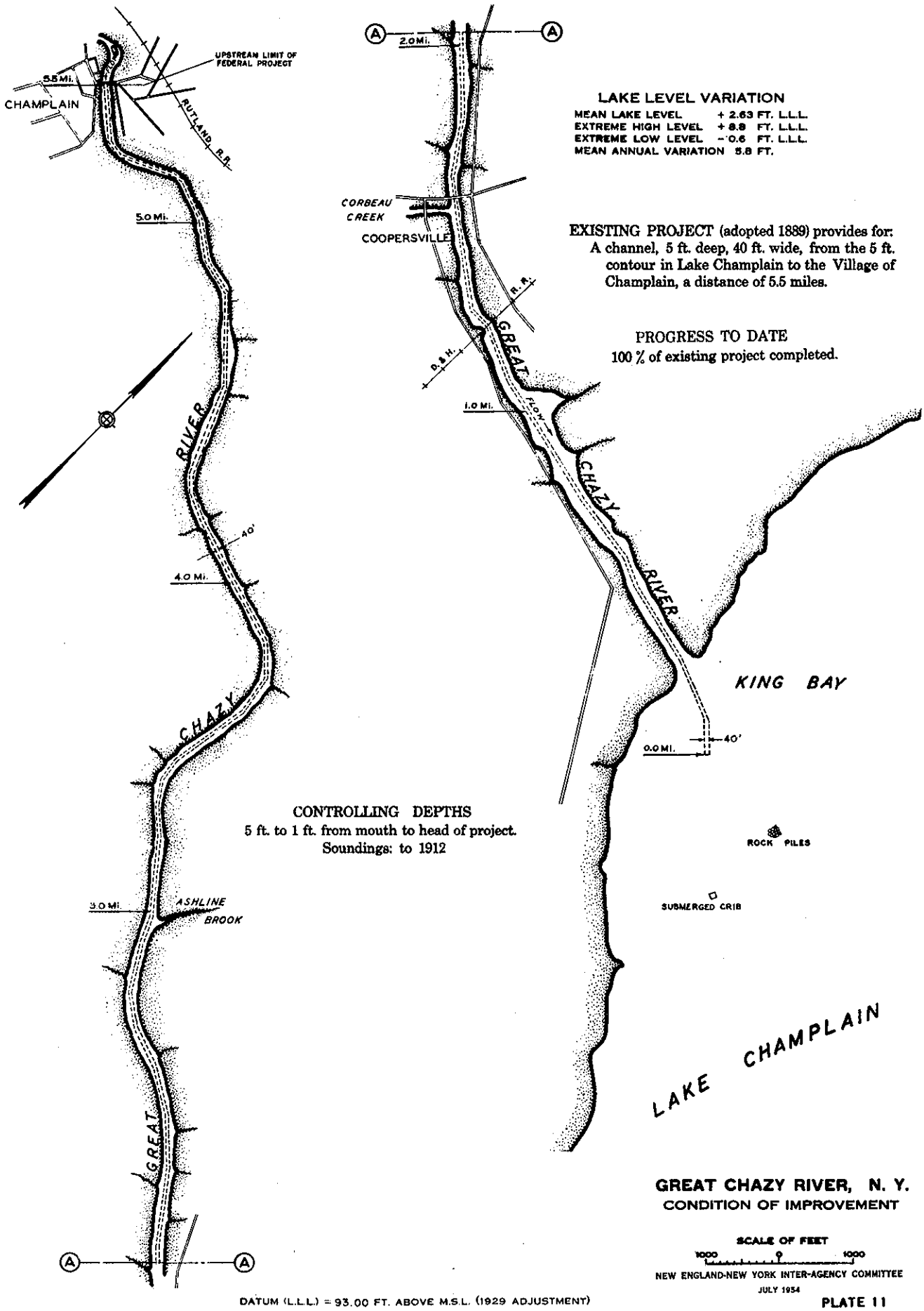
SCALE OF FEET
1000 0 1000 2000 3000

NEW ENGLAND - NEW YORK INTER-AGENCY COMMITTEE
JANUARY 1954

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

ARMY NYD NEW YORK JANUARY 1954

PLATE 10
CHAPTER XXIX



LAKE LEVEL VARIATION

MEAN LAKE LEVEL	+ 2.63 FT. L.L.L.
EXTREME HIGH LEVEL	+ 8.9 FT. L.L.L.
EXTREME LOW LEVEL	− 0.6 FT. L.L.L.
MEAN ANNUAL VARIATION	5.8 FT.

EXISTING PROJECT (adopted 1889) provides for:
A channel, 5 ft. deep, 40 ft. wide, from the 5 ft. contour in Lake Champlain to the Village of Champlain, a distance of 5.5 miles.

PROGRESS TO DATE
100 % of existing project completed.

CONTROLLING DEPTHS
5 ft. to 1 ft. from mouth to head of project.
Soundings: to 1912

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

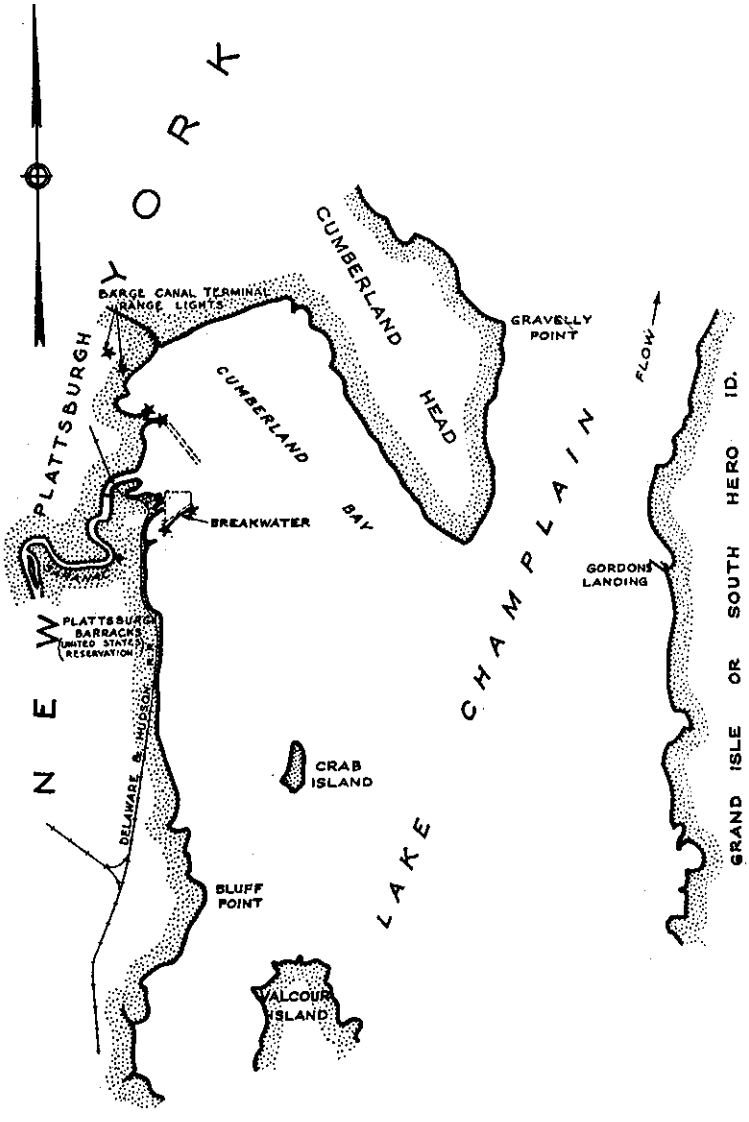
GREAT CHAZY RIVER, N. Y.
CONDITION OF IMPROVEMENT

SCALE OF FEET
1000 0 1000

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
JULY 1954

PLATE 11
CHAPTER XXIX

ARMY NYD NEW YORK JULY 1954



LAKE LEVEL VARIATION

MEAN LAKE LEVEL	+2.63 FT. L.L.L.
EXTREME HIGH LEVEL	+8.6 FT. L.L.L.
EXTREME LOW LEVEL	-0.6 FT. L.L.L.
MEAN ANNUAL VARIATION	5.8 FT.

BREAKWATER
Completed to project length and in good condition.

REVETMENT
No work has been done.

EXISTING PROJECT (adopted 1836, modified to 1910) provides for:
A breakwater about 1565 ft. long.
Dredging an area between the breakwater and the wharves to 9 ft. depth.
Revetment of the beach in front of the United States reservation.

PROGRESS TO DATE
100% of existing project completed.

CONTROLLING DEPTH
9 ft. between the breakwater and wharves.
Soundings: to 1950.

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

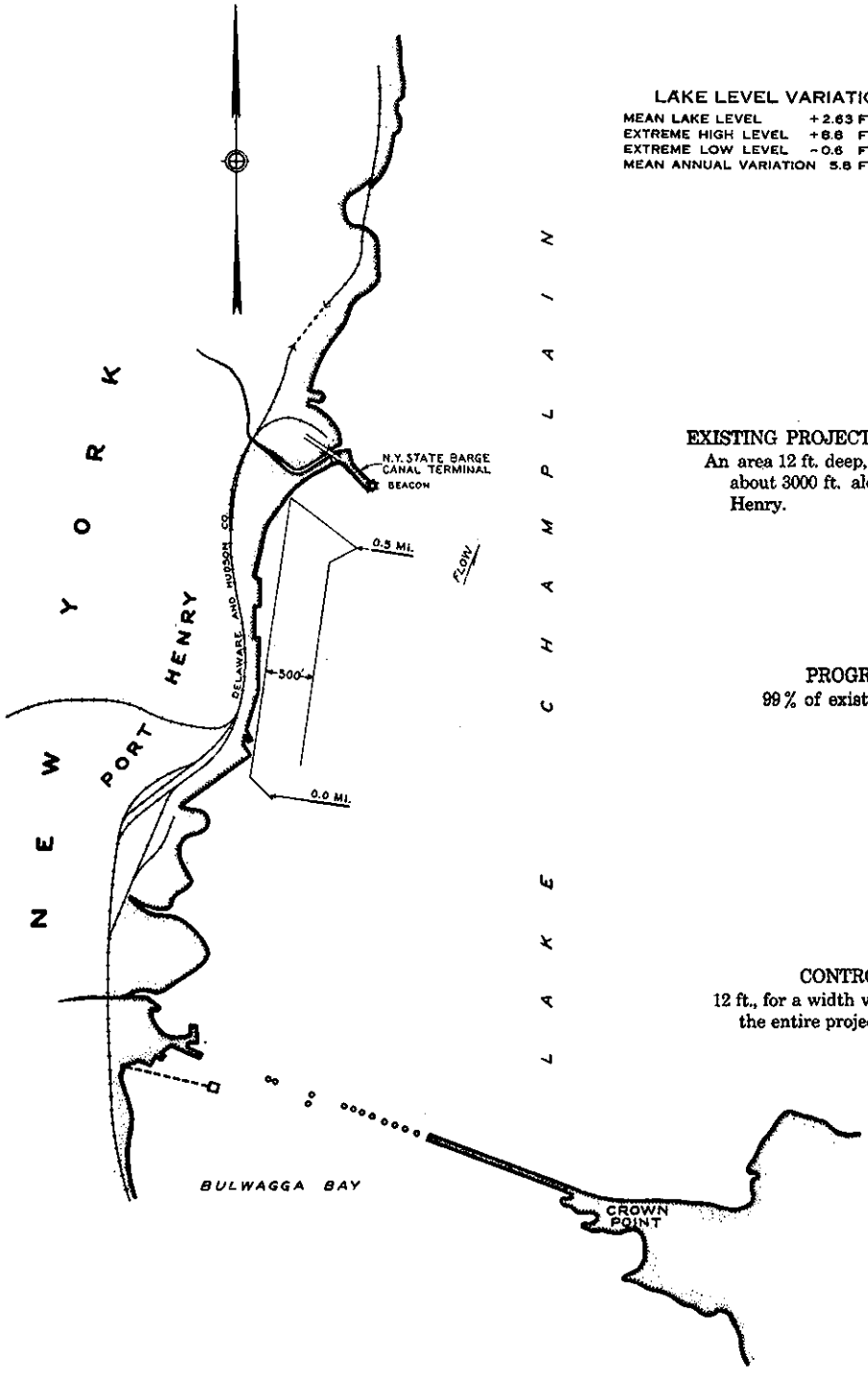
ARMY NYD NEW YORK JULY 1954

PLATTSBURGH HARBOR, N. Y.
CONDITION OF IMPROVEMENT

SCALE OF FEET
5000 0 5000 10000

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
JULY 1954

PLATE 12
CHAPTER XXIX



LAKE LEVEL VARIATION

MEAN LAKE LEVEL	+2.63 FT. L.L.L.
EXTREME HIGH LEVEL	+6.6 FT. L.L.L.
EXTREME LOW LEVEL	-0.6 FT. L.L.L.
MEAN ANNUAL VARIATION	5.8 FT.

EXISTING PROJECT (adopted 1917) provides for:
An area 12 ft. deep, 500 ft. wide, and extending about 3000 ft. along the waterfront of Port Henry.

PROGRESS TO DATE
99 % of existing project completed.

CONTROLLING DEPTH
12 ft., for a width varying from 200 to 410 ft., for the entire project length.

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

PORT HENRY HARBOR, N.Y.

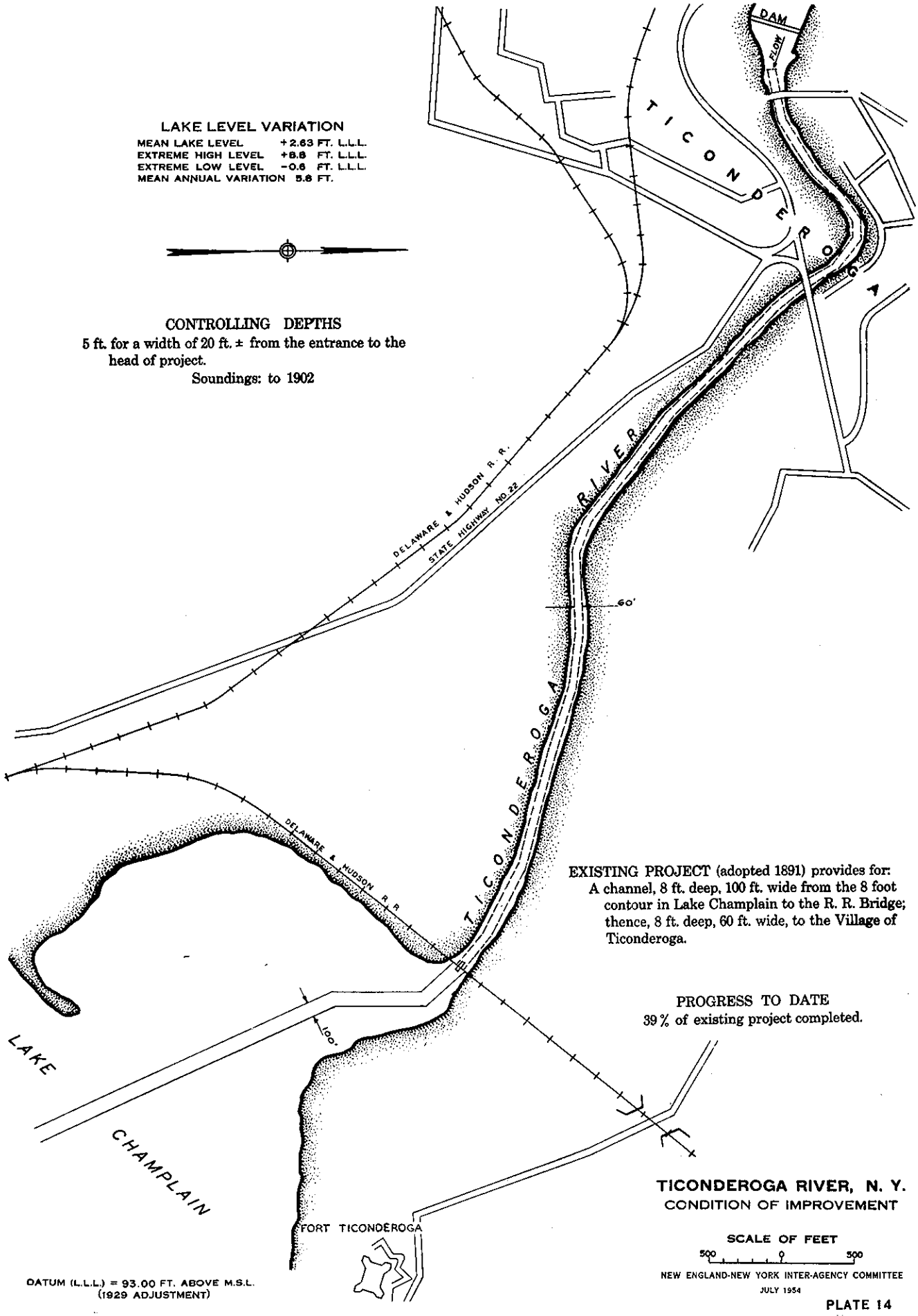
CONDITION OF IMPROVEMENT

SCALE OF FEET
1000 0 1000 2000

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
JANUARY 1954

PLATE 13
CHAPTER XXIX

ARMY NYD NEW YORK JANUARY 1954



LAKE LEVEL VARIATION

MEAN LAKE LEVEL	+2.63 FT. L.L.L.
EXTREME HIGH LEVEL	+8.8 FT. L.L.L.
EXTREME LOW LEVEL	−0.6 FT. L.L.L.
MEAN ANNUAL VARIATION	5.6 FT.

CONTROLLING DEPTHS

5 ft. for a width of 20 ft. ± from the entrance to the head of project.

Soundings: to 1902

EXISTING PROJECT (adopted 1891) provides for:
A channel, 8 ft. deep, 100 ft. wide from the 8 foot contour in Lake Champlain to the R. R. Bridge; thence, 8 ft. deep, 60 ft. wide, to the Village of Ticonderoga.

PROGRESS TO DATE

39 % of existing project completed.

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L.
(1929 ADJUSTMENT)

TICONDEROGA RIVER, N. Y.

CONDITION OF IMPROVEMENT

SCALE OF FEET

500 0 500

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
JULY 1954

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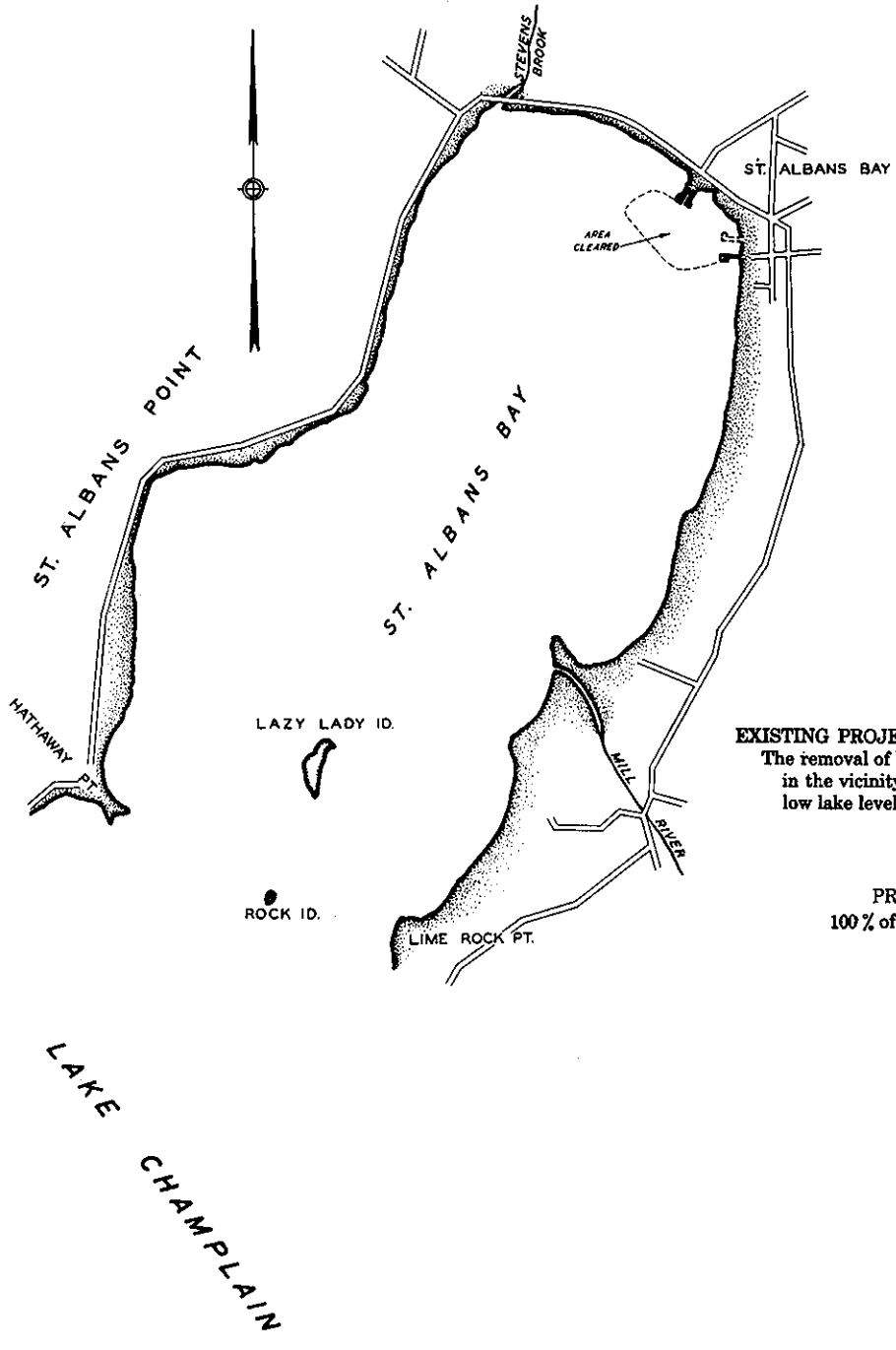
CHAPTER XXIX

ARMY NYD NEW YORK JULY 1954

LAKE LEVEL VARIATION

MEAN LAKE LEVEL	+2.63 FT. L.L.L.
EXTREME HIGH LEVEL	+6.6 FT. L.L.L.
EXTREME LOW LEVEL	−0.6 FT. L.L.L.
MEAN ANNUAL VARIATION	5.8 FT.



EXISTING PROJECT (adopted 1910) provides for:
The removal of boulders and other obstructions in the vicinity of the wharves to 6.5 ft. deep at low lake level.

PROGRESS TO DATE
100 % of existing project completed.

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

ARMY NYD NEW YORK JANUARY 1954

ST. ALBANS HARBOR
(LAKE CHAMPLAIN), VT.
CONDITION OF IMPROVEMENT

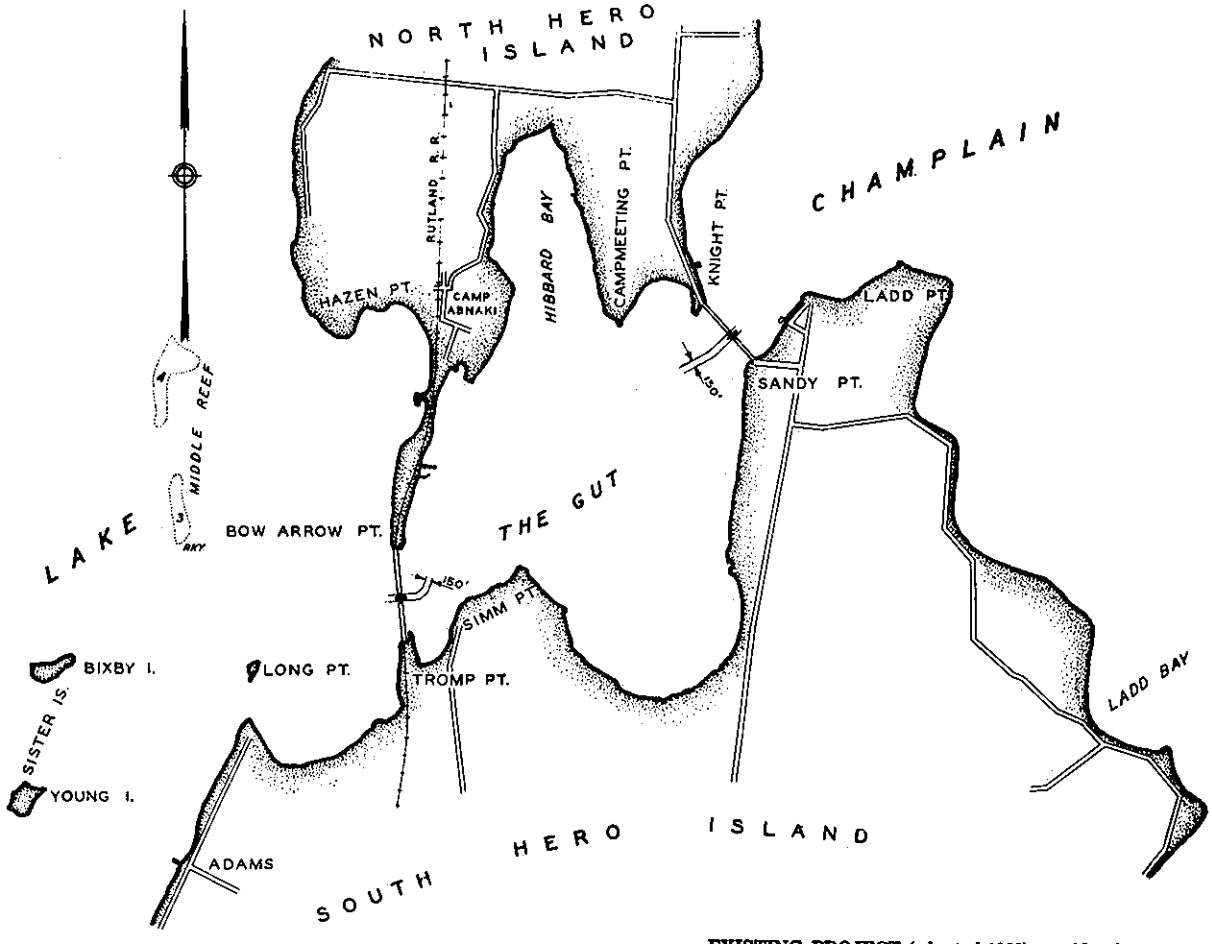
SCALE OF FEET
1000 0 1000 2000 3000

NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE
JANUARY 1954

PLATE 15
CHAPTER XXIX

LAKE LEVEL VARIATION

MEAN LAKE LEVEL + 2.63 FT. L.L.L.
EXTREME HIGH LEVEL + 8.8 FT. L.L.L.
EXTREME LOW LEVEL − 0.6 FT. L.L.L.
MEAN ANNUAL VARIATION 5.8 FT.



EXISTING PROJECT (adopted 1888) provides for:
A channel, 10 ft. deep and 150 ft. wide at both entrances.

CONTROLLING DEPTHS
10 ft. for a width of 150 ft. in the west entrance except for a minor shoal at a least depth of 8.5 ft.
8 ft. for a width of 75 ft. in the east entrance.
Soundings: to 1907

PROGRESS TO DATE
100 % of existing project completed.

CHANNEL BETWEEN NORTH AND SOUTH HERO ISLANDS, LAKE CHAMPLAIN, VT.

CONDITION OF IMPROVEMENT

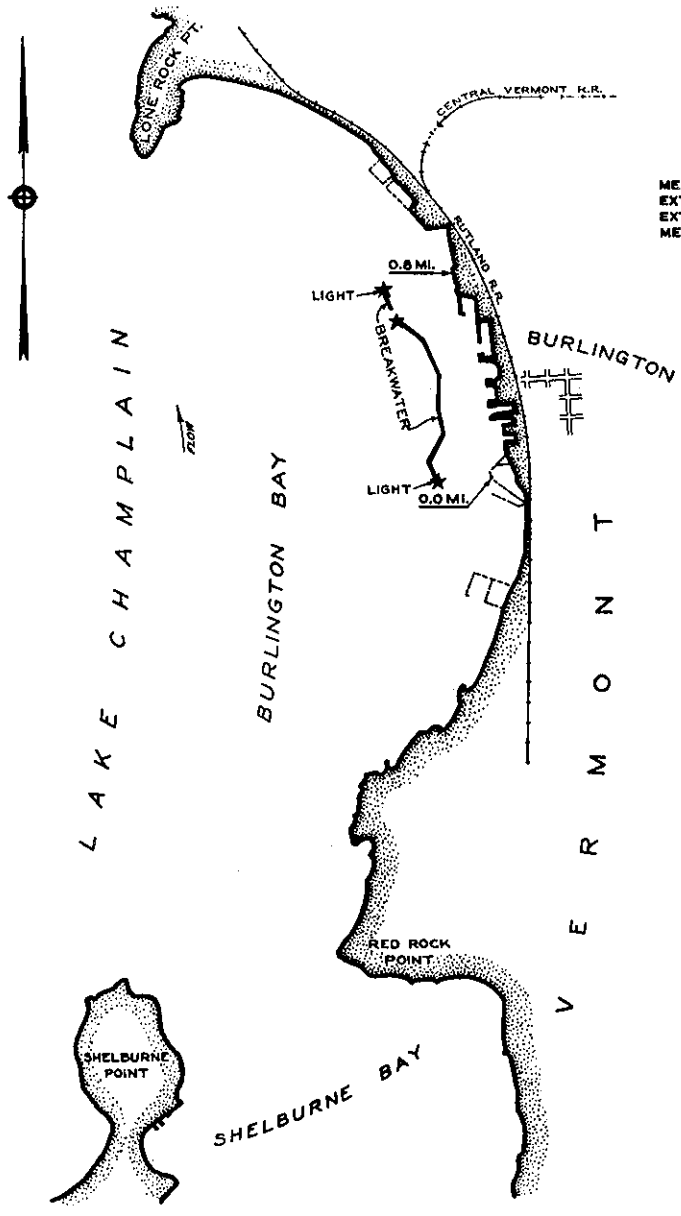
SCALE OF FEET
1000 0 2000 4000

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

NEW ENGLAND - NEW YORK INTER-AGENCY COMMITTEE
JANUARY 1954

ARMY NYD NEW YORK JANUARY 1954

PLATE 16
CHAPTER XXIX



LAKE LEVEL VARIATION

MEAN LAKE LEVEL	+ 2.63 FT. L.L.L.
EXTREME HIGH LEVEL	+ 8.8 FT. L.L.L.
EXTREME LOW LEVEL	− 0.6 FT. L.L.L.
MEAN ANNUAL VARIATION	5.6 FT.

EXISTING PROJECT (adopted 1836, modified to 1875) provides for:
A breakwater 6000 ft. long in two sections.

Soundings: to 1948.

PROGRESS TO DATE
100 % of existing project completed.

BREAKWATER
4157 ft. constructed with 1700 ft. of rubble mound.
Further construction unnecessary.

DATUM (L.L.L.) = 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

ARMY NYD NEW YORK JANUARY 1954

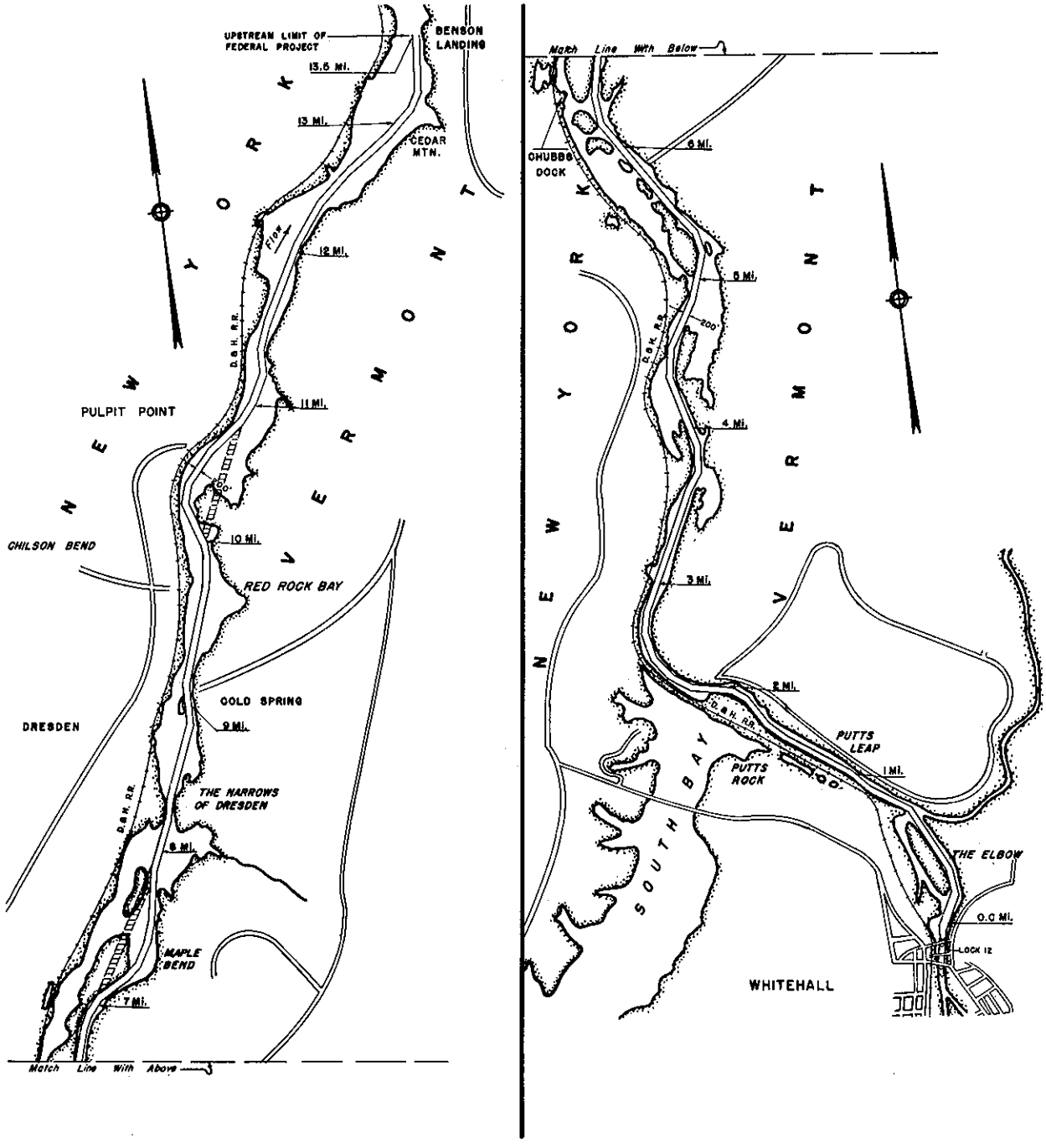
BURLINGTON HARBOR, VT.

CONDITION OF IMPROVEMENT

SCALE OF FEET
2000 0 2000 4000

NEW ENGLAND - NEW YORK INTER-AGENCY COMMITTEE
JANUARY 1954

PLATE 17
CHAPTER XXIX



EXISTING PROJECT (adopted 1917) provides for:
A channel, 12 ft. deep, and generally 200 ft. wide, from Whitehall, N. Y. to Benson Landing.

The installation of fender booms at Putts Rock, Putts Leap, Narrows near Dresden, Pulpit Point, and Cedar Mountain. Length-abouth 13.5 miles.

LEGEND

NEW WORK REMAINING TO BE DONE.

DATUM (L.L.L.) – 93.00 FT. ABOVE M.S.L. (1929 ADJUSTMENT)

NARROWS OF LAKE CHAMPLAIN, N. Y. & VT.

CONDITION OF IMPROVEMENT

SCALE OF FEET

1000 0 1000 3000 5000

NEW ENGLAND - NEW YORK INTER-AGENCY COMMITTEE

JANUARY 1954

PLATE 18

CHAPTER XXIX

ARMY NYD NEW YORK JANUARY 1954

SECTION IV - HISTORICAL BACKGROUND

THE GREAT NORTHERN WAR TRAIL

1. In Subregion "C" the central mass of the Adirondacks and the high slopes of the Green Mountains seem never to have been used by prehistoric peoples except as hunting ground. But along the major water routes, migrations passed and repassed. Traces of successive groups of prehistoric peoples have been found along the St. Lawrence River and on both shores of Lake Champlain. At the time of white contact, however, most of this country lay in a sort of no-man's land between the Algonquin tribes of eastern Canada and the Iroquois Confederacy of New York.

2. The archeology of the country west from Lake Champlain to the St. Lawrence River has been explored and mapped under the direction of the New York State Museum. The archeology of Vermont is now undergoing systematic investigation through collaboration among Middlebury College, the Vermont Historical Society, and the New York State Museum. While much scientific material of value has come to light, no prehistoric sites are presently known in the subregion that are capable of development as exhibits of major educational value.

3. When Samuel de Champlain, founder of Canada, joined a group of Algonquin warriors in the summer of 1609 in an expedition against their hereditary enemies the Iroquois, the route they followed was already old in war. For another two centuries it was to continue to

be a highway of battle. Champlain's allies led him up from the St. Lawrence River by the stream later called the Richelieu River, into the magnificent lake between the mountain ranges that now bears his name. Toward the south end of the lake, where it narrows to a ribbon of water leading on through the mountains south to the Hudson River, they met the enemy and, with the aid of the white man's firearms, vanquished him.

4. It would be highly unrealistic to attribute the long enmity of the Iroquois toward the French in Canada to this little skirmish on Lake Champlain. Nevertheless, the incident was prophetic. During much of the 17th century there was warfare between the Iroquois on the one hand and the French and their Indian allies on the other; Lake Champlain and its connecting waters being the principal war trail.

5. As the Dutch and later the English established themselves along the Hudson River, they supplied the Iroquois with firearms in exchange for beaver pelts. As colonial rivalry intensified, the English applauded the use of these arms against the French. With the outbreak of formal warfare between England and France in 1689, this relationship of the English with the Iroquois took on the status of a military alliance.

6. Until the final surrender of French Canada to England in 1760 war parties and armies followed the lake pathway through the

mountains between Albany and Montreal. After Canada became British and the colonies to the south sought to establish an independent nation and to include Canada within its borders, the opposing teams in the grim game of war were different but the game itself and the field on which it was played remained the same. In the American Revolution and still later in the War of 1812 the Lake Champlain route was taken by invading armies, whether moving south or north, and fleets fought for domination of the waters.

7. Father Isaac Jogues, Jesuit missionary soon to be martyred by the Mohawks, made the first recorded journey by a white man over the length of the water route from the St. Lawrence River to the Hudson River in 1646. The French in 1666 built the first fort on Lake Champlain, Fort Ste. Anne at Isle LaMotte near the northern end, a stockade designed as an offensive and defensive base against the Iroquois.

8. In the 18th century, as the international struggle intensified, French posts were built farther south on the lake, while British fortified positions appeared along the southern reaches of the waterway. The French Fort St. Frederic was erected at Crown Point in 1731, and strengthened in later years. It was supported by a colony centered across the lake at Chimney Point, for the French meant to make the Champlain Valley an integral part of Canada. From Crown Point war parties ravaged the New York-New England Border in King George's

War 1744-1748). British forts, meanwhile, were built, abandoned and rebuilt on the upper Hudson River and on Wood Creek, reached from it by a low portage and flowing into Lake Champlain.

9. In 1755, an army of British colonials and Mohawks under Sir William Johnson set out by the upper Hudson River and Lake George route to take Crown Point. A French counter-offensive under the Baron Dieskau moved swiftly from Crown Point to the southern tip of Lake Champlain, crossing over the low portage to the Hudson River to take Johnson in the rear. In a confused and savage battle on the shore at the head of Lake George the French were driven back. Following it the English built Fort William Henry on a low bluff near the battlefield, while the French, retiring, took up a new position at Ticonderoga, where Lake George empties into Lake Champlain. This post, which they named Fort Carillon, was first built of logs but was soon rebuilt in stone along the classic lines of Vauban.

10. For four years the struggle swayed back and forth between these two opposing positions at Ticonderoga and Fort William Henry. The regular armies with their bright banners and gay uniforms moved to battle on the blue lake between the forest-clad hills in stately flotillas of barges and bateaux. In canoes and through the woods, and on the ice in winter, there were savage raids and counter-raids of French"coureur de bois"and Indian against British colonial ranger.

11. In 1757 the Marquis de Montcalm, the new French commander, swept up Lake George from Ticonderoga with a strong train of artillery

and battered Fort William Henry into submission. Lacking land transport, he retired to his base without pursuing the British down the Hudson River, after turning the log fort and its dead into a great funeral pyre. In the next year the British General Abercrombie led an army of 15,000 men down the lake to Ticonderoga to make a rash frontal attack, meet a bloody repulse and retire in panic. In 1759 Jeffrey Amherst, his successor in command, built Fort George not far from the ruins of Fort William Henry and from it began a cautious advance against the French stronghold. Formal siege operations were undertaken, but before the full power of Amherst's artillery was brought to bear, the French garrison abandoned Fort Carillon, blowing up one of its bastions.

12. Amherst, always methodical, repaired the fort, renamed it Fort Ticonderoga, and pushed on against the older French post at Crown Point,ten miles to the north. Fort St. Frederick, almost a medieval castle in form, was quickly destroyed and evacuated by its garrison, the French colonists at Chimney Point abandoning their homes at the same time. Not far from the ruins of Fort St. Frederic, Amherst built Fort Crown Point, a powerful bastioned work with supporting outworks, cut in part out of the solid rock and designed, as he said, to "give plenty, peace, and quiet to His Majesty's subjects for ages to come". To support the fort he ordered a road cut through the wilderness of Vermont from the British frontier posts on the Connecticut River to Chimney Point.

13. Amherst went no farther north that year, while General Wolfe was besieging Quebec and dying in hard-won victory. In 1760 Amherst led an army back down the Hudson River, up the Mohawk, and by Lake Ontario and the St. Lawrence River to Montreal. A supporting force moved by the direct route from Crown Point down Lake Champlain and overland to meet him, while the British troops that had taken Quebec moved up the St. Lawrence to complete the concentration. At Montreal in that year the last flicker of French resistance was put out and Canada thereafter became a British Colony.

THE NEW HAMPSHIRE GRANTS

14. While France and Britain were reaching the climax of their long struggle for domination in North America, with the Champlain Valley a chief theater of war, another conflict for control of much of this region was developing. In 1749 Benning Wentworth, royal governor of New Hampshire, issued to himself and a group of friends a grant of a township of land not only west of the Connecticut River but also west of the Green Mountains. The town of Bennington was in a region claimed by the colony of New York, which held to the royal grant of 1664 setting its eastern boundary at the Connecticut River. But Connecticut and Massachusetts had been able to set aside this royal edict in the case of their own western boundaries, finally established on a line roughly twenty miles east of the Hudson and parallel to it. Governor Wentworth claimed the same boundary for New Hampshire.

15. The dispute was referred to the British government which, in the leisurely manner of the 18th century, failed to issue a decision for many years. Wentworth, meanwhile, in spite of a gentleman's agreement not to issue grants in the disputed region, continued to make out land warrants to his friends and relatives and gentlemen in various colonies until the choicest parts of what is now Vermont, including the eastern shore of Lake Champlain, were covered with them. The fees collected for these grants formed an important perquisite of his office, and he thoughtfully reserved 500 acres in each township for himself.

16. Vermont was, during the colonial wars, almost wholly beyond the frontier. Through the notches of the Green Mountains, up and down the rapid little rivers flowing into Lake Champlain and the Connecticut River, raiding parties from Crown Point and other French bases moved swiftly and silently, to strike at the borders of Massachusetts and New Hampshire. As French power collapsed, this terror vanished and settlement became possible. In the 1760's settlers from Connecticut and Massachusetts began pushing north into Vermont on both sides of the mountains, buying their land from Wentworth grantees.

17. In 1764 the royal government in England at last gave its decision in favor of the claims of New York. At once all titles west of the Connecticut River issued under the authority of New Hampshire were seriously threatened. New York began issuing grants

of its own covering the same territory, and finally brought ejectment suits in its court at Albany against some of the New England settlers. New York land speculators, long a powerful group in the colony, were interested in the case and the decision almost inevitably went in their favor.

18. But while the forces of the law were being marshalled against the settlers in what was then called the New Hampshire Grants, the settlers themselves were far from passive. Small communities of the New England type were appearing not only in the Connecticut Valley but also west of the mountains from Bennington northward. In addition to small farmers hacking out homes in the forest, the new communities included aggressive men from Connecticut and Massachusetts who had taken up the fascinating game of land speculation themselves.

19. It was legally possible to have a New Hampshire land title confirmed by paying a fee to New York. Such fees were not prohibitive on a single farm, but men who had stretched their credit to the limit in buying up titles to large tracts of land from Wentworth's friends were threatened with ruin. It was this group, including the Allen brothers of Connecticut, that led a movement to defy the authority of New York. The emerging American concept of "squatter's rights" combined with the active interest and leadership of a shrewd and vigorous group of promoters to form a powerful alliance.

20. Ethan Allen, who, with his brother Ira, was deeply involved in land speculation, quickly came forward as the leader and vociferous spokesman of the New England interests. At Albany in 1770 he attended court and saw the decision go against him. "The gods of the hills are not the gods of the valleys" he told the Yorkers. This cryptic observation took on meaning as Allen returned to Bennington and organized the Green Mountain Boys. This organization, soon known to the Yorkers as the "Bennington Mob" undertook to prevent surveys and settlement under New York grants, and finally to eject all representatives of that colony's authority.

21. The first open clash took place in the same year, when the sheriff of Albany with a large posse attempted, under the recent court decision, to dispossess James Breakenridge, a settler near Bennington. The sheriff's party was met by a show of armed force and retired in some confusion. For the next few years a limited sort of warfare was continued against the Yorkers. Surveyors of New York grants were beaten and their instruments were broken. Settlers who had the temerity to take up land under New York titles were forced to stand by while their houses were burned. There were raids by law officers from New York and dramatic rescues by the Green Mountain Boys. New York officials who tried to carry on their functions in the New Hampshire Grants were driven off with beatings and blood-curdling threats.

22. This conflict, however, never quite reached the point of a shooting war. A New York edict of outlawry issued against Allen and his associates was defied with ferocious proclamations directed against the New York land speculators, but there was no actual killing in the country west of the mountains where the Green Mountain Boys were supreme. Allen and Seth Warner, his chief lieutenant, were shrewd enough not to lose by bloodshed the popular sympathy they had in all the colonies in their role as bona fide settlers fighting to protect their homes. New York authorities, on the other hand, were too uncertain of the attitude of their own people to call out their colonial militia, and the British military command in North America refused to send royal troops to enforce the colony's authority against the Bennington rebels.

23. Meanwhile, settlement west of the mountains steadily moved established north into the valley of Otter Creek and along Amherst's road to Chimney Point. Well beyond the frontier the Allen brothers and their associates of the Onion River Land Company made preparations to develop their extensive holdings along the Winooski River. At the same time, their hope of union with New Hampshire through a reversal of the royal decision, or of royal confirmation of the New Hampshire land titles, grew dim. A movement began, looking toward a separate colony. The more conservative settlers east of the mountains were now becoming anti-Yorker. Representatives from both slopes of the

Green Mountains met at Westminster in April 1775 to prepare a petition to the crown asking for their separation from New York. This petition was never submitted. News came of the battle of Lexington and larger issues became of paramount importance.

24. The Green Mountain Boys in their operations against New York had ranged the length of the western slope of the mountains, from Bennington to what is now Burlington. In Old Bennington the site of the Catamount Tavern, where they often gathered, is now marked by the bronze figure of a mountain lion, growling defiance in the direction of the New York border. Not far from Bennington the sites of the Breakenridge Farm (the"Birthplace of Vermont") and of Seth Warner's home have been marked, as have the sites of the homes of the Allen brothers at Sunderland, and of the fort they built at Winooski to protect their northern land holdings.

THE NORTHERN FRONTIER IN THE AMERICAN REVOLUTION

25. While the American Revolution broke out in Massachusetts and events around Boston held the center of the stage for the first year of the war, the old highway of armies by Lake Champlain quickly became a strategic one again. Within a month after the battle of Lexington a new theater of operations had been opened in the Champlain Valley.

26. Ticonderoga, with a large equipment of heavy ordnance, was known to have only a small British garrison. Benedict Arnold

an ambitious officer in a Connecticut regiment that had joined in the siege of Boston, persuaded the Massachusetts provisional government to let him raise recruits and attempt the capture of Ticonderoga. Hurrying ahead to make preparations, Arnold found that Ethan Allen and his Green Mountain Boys, with the support of Connecticut authorities, were bent on the same venture. At Castleton, where the attack was planned, Arnold joined them as a volunteer, being unable to assert his right to command.

27. Crossing Lake Champlain, at dawn of May 10, 1775, they surprised the sleeping garrison and captured the famous fortress without the loss of a man. Two days later Seth Warner and another detachment of Green Mountain Boys took Crown Point, while other groups captured Fort George, on Lake George, and Skenesborough (Whitehall), a Tory settlement at the southern tip of Lake Champlain. In a few swift strokes, the whole southern half of the ancient war trail had fallen into American hands, along with a powerful array of artillery, badly needed around Boston.

28. The heavy guns of Ticonderoga were not moved until winter when they could be transported by sled, but they arrived at Cambridge in time to give Washington the artillery power to drive the British out of Boston in March, 1776. Meanwhile, the Continental Congress took up the project of an invasion of Canada and organized an army for the purpose, with its offensive base at Ticonderoga. Major General

Philip Schuyler of New York was given command, with Brigadier General Richard Montgomery as second. The attack by the traditional route was to be supplemented by a force moving up the Kennebec River, through the Maine wilderness, and direct to Quebec. Arnold took command of this detachment.

29. Schuyler was taken ill and Montgomery led the main army in the field. Ethan Allen was captured by the British in a premature attack on Montreal, and disappeared from the scene for a time. St. Johns, a fortified British post on the Richelieu River, put up a strenuous resistance but was finally captured early in November. Montreal capitulated soon after, and Montgomery's force swept down the St. Lawrence to join Arnold, who was already before the walls of Quebec but too weak to attack. A furious surprise assault on the town on New Year's Eve was beaten off with disastrous losses. Montgomery was killed, Arnold wounded, and the famous rifleman, Daniel Morgan, was captured with many of his men.

30. The siege was kept up all winter, but in the spring the American army was driven back up the river, gave up Montreal and in July of 1776 found itself back at its starting point of Ticonderoga. One of the most daring campaigns in American military annals had failed.

31. British reinforcements had meanwhile been reaching Canada in considerable numbers. Sir Guy Carleton, the governor, assembled

a fleet at St. Johns, above the rapids of the Richelieu River, and prepared to move up Lake Champlain. Prefabricated ships, equipment, and training crews were furnished by the royal navy. Arnold, in turn, built a crude squadron at Skenesborough, manned chiefly by soldiers, and prepared to dispute control of the lake.

32. Between Valcour Island and the western shore, on October 11, 1776, Arnold's scratch fleet was defeated after seven hours of fighting. During the night he escaped with most of his ships, but the pursuing British fleet overtook him on October 13th. Arnold's force was wiped out, but his gallant action had stalled British invasion for that year.

33. In 1777 General John Burgoyne assumed the British command in Canada and prepared for an advance to Albany that was designed to end the war. The main army went by Lake Champlain, while a supporting attack moved up the St. Lawrence River by Lake Oswego to the Mohawk River. The American army at Ticonderoga, now under General Arthur St. Clair, had fortified both shores of the lake, the principal garrison being on the Vermont side at Mount Independence, connected with Fort Ticonderoga by a floating bridge. Crown Point was not defended.

34. Burgoyne's advance swept around Fort Ticonderoga and on July 5th his artillery was planted on the height of Mount Defiance, overlooking both the old fort and Mount Independence opposite.

St. Clair's position became untenable and his army withdrew under cover of night, the troops marching southeast through Vermont, the movable stores going south by boat to Skenesborough.

35. British pursuit was swift. The American army had halted at Castleton, with its rear guard at Hubbardton under Seth Warner, now a Continental colonel. At dawn of July 7th the British advance guard caught Warner's men at breakfast. In spite of surprise, they fought a fierce delaying action, both sides losing heavily. Warner's force was at last dispersed, but the British pursuit went no farther.

36. St. Clair's little army made a circuit by way of Rutland, then cutting west to reach the Hudson at Fort Edward. Burgoyne's main body of troops had meanwhile moved up the lake to Skenesborough and prepared to cross over to the Hudson River. Fort George, at the head of Lake George, was also occupied and Burgoyne later made the Lake George route his line of supply.

37. The American troops fell back as Burgoyne advanced. Early in August, 1777, with his army moving down the Hudson River, Burgoyne sent a strong detachment toward Bennington, to capture the supplies collected there and gather horses for his dismounted dragoons. General John Stark of New Hampshire, with a force that included Warner's Vermont regiment, met this large raiding party some miles outside the town and destroyed it. The battle of Bennington, August 16, 1777 was the beginning of the end of Burgoyne.

38. After the surrender of the British army at Saratoga in October, 1777, the northern front became of secondary importance. The British garrisons on Lake Champlain left behind by Burgoyne retired to Canada, burning the buildings at Fort Ticonderoga and Mount Independence and partially wrecking the fortifications. British Tory and Indian raids, however, sometimes swept down from the north, and until the end of the war the frontier in Vermont was pushed back to a line of stockaded posts through Castleton and Pittsford.

39. In 1780-81 British troops briefly occupied Ticonderoga once again, but its great military significance had passed. Farther west, the St. Lawrence pathway served the British in Canadaas a supply line to Fort Haldim, near the outlet of Lake Ontario, and to Fort Niagara. From these two bases the Mohawk and Susquehanna Valleys were raided from time to time until the close of hostilities.

VERMONT - REPUBLIC AND STATE

40. The patriotic outburst that followed the battle of Lexington halted for a time the bitter strife between Yankee and Yorker over the Green Mountain country. Seth Warner's commission as a colonel was actually issued to him by New York and Ethan Allen boldly demanded aid from Albany to help hold Ticonderoga after he had captured it.

41. But action in the direction of independence was going forward in all the colonies. A series of conventions in the New

Hampshire Grants discussed the problems of the political future. It was perhaps natural that independence from New York should take precedence in their view over independence from Great Britain. At Dorset, on the west side, a meeting attended by a small number of delegates from the Connecticut Valley, resolved in September 1776 that the Grants should be formed into "a separate district," and refused to be bound by any New York law "for the time being". In January of the following year, another meeting at Westminster, attended by men from the western slope, voted that the "New Hampshire Grants be a new and separate state.....forever after to be called by the name of New Connecticut."

42. Lingering sentiment in much of the Connecticut Valley in favor of New York was alienated when the news of the conservative constitution adopted by that State was received in the spring. New York's constitution affirmed the validity of its colonial land grants and reserved to the State the quit rents formerly paid to the King. It also restricted suffrage by property qualifications and had other features considered undemocratic on the frontier.

43. At Windsor in July another convention reasserted the independence of what was now to be known as the State of Vermont, and framed a constitution along the democratic lines of that of Pennsylvania. Additional features prohibited slavery, established manhood suffrage, and made a gesture in the direction of religious freedom.

44. Concessions were offered by New York in the following year, including confirmation of the New Hampshire land titles to all who would acknowledge the jurisdiction of New York. But these came much too late. Vermont was launched on its career towards becoming an independent State. New York resentment was powerless to do more than influence the Continental Congress against acknowledging Vermont and admitting it to the union of confederated states.

45. Ethan Allen, returning from a British prison in 1778, quickly overshadowed in political influence the duly elected authorities of the prospective State. Armed with a commission as colonel given him by the Continental Congress in recognition of his services in 1775, this stormy petrel of a man fought down secessionist movements that sprang up in the Connecticut Valley, sought the allegiance of towns along the Hudson River and east of the Connecticut, and carried on a propaganda war with Governor Clinton of New York in an effort to secure acknowledgment of Vermont in the Congress. Rebuffed here, he and his brother Ira negotiated with the British authorities in Canada, seeking either to rejoin the empire at the head of a powerful province to include a good bit of the territory of both New York and New Hampshire, or frighten Congress into admitting Vermont into the confederation.

46. Allen's dealings with the British were known to General Washington and caused him much anxiety about the northern frontier

in the last years of the American Revolution. With the return of peace and the establishment by treaty of an international boundary along the 45th parallel, these intrigues were broken off by the British. The Allens, whose dubious schemes had encountered increasing opposition at home, soon lost political control and influence. Vermont went on its way as a sovereign republic under more conservative leadership. Two capitals, Rutland and Windsor, were established in recognition of the sectional differences found on the two sides of the Green Mountains.

47. The establishment of a strong Federal government in 1789 brought new negotiations looking toward the admission of Vermont into the union. New York was at last induced to withdraw its opposition, on promise of payment of $30,000 for its land claims. On January 6, 1791, a convention at Bennington ratified the Federal constitution and made application to Congress for statehood. On March 4, the United States admitted Vermont as the fourteenth State.

48. The stormy career of the little mountain republic was over, but it had left a heritage of pride and independence that still lives. The exploits of the Green Mountain Boys are vivid legends to Vermonters, and Ethan Allen is to them what Sam Houston is to Texans--the great traditional hero.

SETTLEMENT OF THE NORTH COUNTRY OF VERMONT

49. With the close of hostilities, the tide of settlement swept northward once more. All the Vermont lands that Wentworth's grants had not covered were now offered for sale by the State or granted as Revolutionary bonuses. The fertile lowlands along the shore of Lake Champlain and the many mill sites on Otter Green quickly brought back, together with a swarm of new settlers, the pioneers driven out by Burgoyne and his Indians. Farther to the north the settlement projected by the Allens before the war became the thriving community of Burlington. Towns were established all the way to the Canadian boundary. All the level land by the lake was cleared and put in cultivation, and open farmland began creeping up the mountain slopes. A brisk trade in potash and lumber began with Canada. East of the Green Mountains the growth of Vermont was equally rapid. Montpelier, far to the north and midway in the mountains between the jealous sections of the radical west and the conservative east, became the State capital in 1805.

50. According to the first Federal census of 1790, Vermont had a population of 85,000; in another ten years this had increased by 80 percent to 154,000, and in 1810 the population was 218,000. After that time, population growth leveled off rapidly. Along with the increase of population came cultural advance. A State university was projected at Burlington as early as 1791 and began functioning

ten years later, and a college was founded at Middlebury in 1800. Newspapers appeared on both sides of the Green Mountains. The distinguished Rutland Herald has been in publication since 1794.

51. But even during the years when Vermont was being settled with a steady stream of immigration from the older New England States and becoming a mature commonwealth, the first wave of the exodus that was to scatter its people far and wide was forming. Across Lake Champlain there was a strip of fertile lowland at the foot of the tumbled Adirondacks. Some attempts had been made at settlement there following the French and Indian War but these had been broken up by Burgoyne's invasion. Now Vermonters began to trickle across. Plattsburgh was founded in 1784 and other communities soon appeared on the western shore, populated largely from Vermont. The trickle became a strong current as New York State opened the whole of its North Country for settlement and the gently-sloping crescent of land reaching northward around the Adirondacks into the St. Lawrence Valley was surveyed and offered for sale.

52. New York in 1786 directed the survey of ten townships along the St. Lawrence River and these were sold at auction in the next year. Alexander Macomb, who had made a fortune in the fur trade, was the largest purchaser. At the same time a Military Tract of 665,000 acres was laid out in the eastern Adirondacks. This country did not prove attractive to the New York State Revolutionary War

veterans for whom it was intended, and was eventually sold to other purchasers. In 1791 Macomb bought another 4,000,000 acres of North Country lands, including a large part of the Adirondack country to the west of the Military Tract and much of the fertile fringe around it. This was the largest single sale made by the State in its post-Revolutionary campaign to raise revenue from its wild lands recently acquired from the Iroquois. Macomb, soon after involved beyond his means in varied schemes, transferred most of his holdings to other speculators.

53. Of these, the largest buyer was William Constable. Constable's holdings stretched from the Black River Valley on the west to Saranac Lake on the east, and reached north to the Canadian border. Constable in turn sold large tracts to otherwealthy purchasers, some of whom combined a gamble in wild lands with a dream of baronial estates, in the New York colonial tradition.

54. While a number of these gentlemen or their sons eventually built fine homes in the north, and some even went there to live, the basic pattern stamped on the land was that of the New England settlers who came swarming in with their strong traditions of farm ownership, democratic town government and community church. For the most part, the desirable farmlands were sold in small acreages by the New York operators or their agents on the ground to New England immigrants who came looking for new farm homes. These settlers came

either across Lake Champlain directly from Vermont or by the southern route around the Adirondacks, up the Mohawk River and down the Black River.

55. Ogdensburg was established in 1796 by Nathan Ford, agent of Colonel Samuel Ogden of New York, on the site of the old French fortified mission of La Presentation, held by the British until that year as the military post of the Oswegatchie River. Malone, Potsdam, Canton, and other towns in the fertile crescent beyond the Adirondacks were founded by Vermonters in the early 1800's. Before the outbreak of the War of 1812 a thin line of settlement stretched all the way around the northern flank of the Adirondacks, from Lake Champlain to the head of the St. Lawrence River.

NORTHERN CAMPAIGNS OF THE WAR OF 1812

56. The people of western Vermont were finding their chief economic outlet by Lake Champlain to Canada. Similarly, the new settlers on the St. Lawrence River were attracted to the Montreal market by the current of the river. The whole region was dependent on Canadian trade for anything beyond a bare subsistence farming, and the Embargo of 1808, practically prohibiting foreign trade, was bitterly resented. Smuggling was so strongly supported by popular opinion that rafts of lumber descended Lake Champlain into Canada in full daylight, their crews armed and bidding defiance to the customs officers. Even with the coming of the War of 1812 there was much

traffic with Canada, and the British commanding general reported in 1814 that "two-thirds of the army in Canada are at this moment eating beef provided by American contractors, drawn principally from the States of Vermont and New York."

57. It does not follow that Vermont and the North Country were populated by traitors. Trading with the enemy was an old Colonial custom; the modern concept of total war has been developed gradually. The militia turned out on call and, when well led, gave a good account of themselves. The Vermont militia, in fact, defied the orders of their own governor not to leave the State when Plattsburgh was threatened by the British and crossed Lake Champlain in large numbers to its defense. On the St. Lawrence River, the militia under the leadership of General Jacob Brown did well in defending Ogdensburg from British raids.

58. The War of 1812 inevitably turned much of the subregion into a theater of operations--rather, into two strategic areas, that of Lake Champlain and that of the St. Lawrence River--Lake Ontario route. As in the Colonial wars and the American Revolution, these routes were used for attempted invasions. The St. Lawrence River, moreover, was the British supply line for its operations at Niagara and Detroit.

59. The most ambitious military enterprise during the war by the St. Lawrence River route was an American attempt to capture

Montreal late in 1813. General James Wilkinson assembled a considerable force at Sackets Harbor, the American base at the eastern end of Lake Ontario, and started down the river by boat in October.

60. If the choice of a commander of doubtful loyalty and military competence had not been sufficient to doom the enterprise, other factors went far toward guaranteeing failure. General Wade Hampton, in command on Lake Champlain, was to cooperate in the movement, and Hampton despised Wilkinson. Both distrusted Armstrong, the Secretary of War, who had planned the enterprise. When the American troops started down the St. Lawrence River, they left the strong British base of Kingston, Ontario, in their rear, and other fortified posts were left along the Canadian shore of the river. Montreal itself was strongly garrisoned.

61. British gunboats and troops from Kingston pursued and harassed the American army. An American force thrown across the river above the rapids of the St. Lawrence River was badly defeated at Chrystler's Farm. Hampton, moving west and north into Canada from Lake Champlain, was checked on the Chateaugay River and retreated to Plattsburgh. Wilkinson abandoned the offensive and went into winter quarters at French Mills (Fort Covington), on the border. Here the supply of the army became almost impossible and before spring the force was broken up, part of the troops being sent back to Sackets Harbor, the rest to Plattsburgh.

62. In 1814 the British made their most ambitious effort of the war in the northern theater, a major invasion by the traditional route of Lake Champlain. Napoleon had been defeated and Wellington's veterans were available for the American war. The force assembled in Canada under Sir George Prevost was the largest and finest army Britain had ever sent to North America. It was supported by a strong squadron built at St. Johns.

63. The Americans made their stand at Plattsburgh, New York, which had become their principal post on Lake Champlain. The south bank of the Saranac River near its mouth had been strongly fortified, but the garrison was not large, most of the troops having been ordered to Sackets Harbor just as the invasion was impending.

64. The principal strength of the Americans, however, lay in their naval commander, Thomas Macdonough. He had been sent to Lake Champlain to construct and command a fleet in 1813. Operations on the lake that year went in favor of the British and Macdonough, seeking a safe base in which to build up his strength, selected Vergennes, seven miles from the lake up Otter Creek. A fort was built at the mouth of the creek and the broad basin at the foot of the falls in Vergennes became a scene of feverish activity. A new flagship, the Saratoga, was built and launched in forty days from the standing timber. Other craft were added and in the spring Macdonough took his little fleet down the lake and maneuvered it.

65. As the British moved down from Canada, Macdonough took up his station in Plattsburgh Bay, where fleet and forts could support each other. The British army occupied the town of Plattsburgh but postponed any large-scale attack on the forts across the river until they could have naval support.

66. On the morning of September 11, the British fleet rounded Cumberland Head at the mouth of the bay and attacked Macdonough, who fought at anchor. After two hours of close cannonading, the Americans were near defeat. At this point Macdonough, who had planned the maneuver, turned his ship around with kedge anchors, presenting a fresh broadside to his opponent. This operation decided the battle and in another half hour the British fleet surrendered.

67. On shore the British commander immediately ordered a retreat. The great invasion, designed to conquer territory for annexation to Canada, was over. The news of the battle of Plattsburgh forced the British commissioners, then discussing terms of peace at Ghent, to drop their demands for territorial cessions. It has been called the one decisive action of the war.

68. The battle of Plattsburgh practically ended the War of 1812 on the northern front. It was the last military operation on the ancient highway of battle that led through Lake Champlain.

69. After the war the flow of immigration began once more and the low-lying parts of the North Country quickly developed into well-established communities. Settlement had now completely surrounded the Adirondack Mountains and attempts were already being made to exploit the resources within them. This tangled country of mountains, lakes, streams, and swamps had never been permanently inhabited by Indians or European settlers, though it had always been known as fine hunting ground. The first crossing of the Adirondacks of which any record had been made was that of Sir John Johnson and his Tory followers fleeing to Canada from Johnstown, New York, in 1776.

70. Early in the 19th century iron ore of high quality was discovered in the eastern slopes of the Adirondacks toward Lake Champlain, in the Saranac Valley and elsewhere. As the Champlain Canal (1823) tied the lake country commercially to New York, this ore was shipped to Troy and other rising manufacturing centers. Iron mining reached its peak in the 1840's, but some Adirondack mines, because of the superior grade of their ore, were able to survive after the opening of the vast Lake Superior iron ranges and the change from charcoal to coal in smelting, that came in the mid-18th century.

71. There were also attempts to clear Adirondack valleys for farming, but these generally failed as a result of the rigors of the climate, the thinness of the soil, and the difficulties of

transportation. As good timber was cleared from the lower country, lumbering pushed farther and farther up the streams that came tumbling out of the highlands. The whole area was finally threatened with the possibility of becoming a waste of stumpland, unfit for cultivation and a desolation.

72. While the Adirondack lumbering industry was still far from its peak, another concept of the best use of this wild and beautiful country began to take form. Gentlemen of wealth took to organizing hunting and fishing trips to the Adirondacks. The professional hunters and trappers who had moved into the country at an early date gradually acquired a new specialty and became guides. Hunting camps, at first crude and temporary, became sometimes elaborate structures intended for use year after year.

73. In 1858 the Saturday Club of Boston, a group of intelligentsia that included Ralph Waldo Emerson and Louis Agassiz, spent part of the summer in the Adirondacks, attracting a good bit of attention. In the same year William J. Stillman, who had sponsored the excursion, bought 25,000 acres on Ampersand Lake as a home for the Adirondack Club, an outgrowth of the same recreational gathering.

74. The big rush to the Adirondacks began a few years later, with the publication in 1869 of Reverend William Henry Harrison Murray's book, "Adventures in the Wilderness, or Camp Life in the Adirondacks". This book, extolling the virtues of the outdoor life and the healthgiving qualities of the Adirondacks in particular,

became immensely popular and started a summer migration that took on large proportions. The tourist traffic to the Adirondacks every summer has never ceased. Winter sports developed in recent years now make the region a year-round resort center. Summer hotels and permanent summer camps began to replace hunters' lodges after Murray's book was published, and the penetration of this area by railroads late in the 19th century made these facilities readily accessible to distant city dwellers, including those with low incomes.

75. Murray's book had emphasized the benefits of the Adirondack climate to the victims of tuberculosis. In 1876 Dr. Edward Livingston Trudeau, a New York physician who had contracted the disease, went to Saranac Lake expecting to die. Finding himself much better, he established the first outdoor sanatorium for the treatment of tuberculosis, and the first laboratory for the scientific study of the disease. The Trudeau Sanatorium and Saranac Laboratory have since become world famous.

76. Along with the concept of outdoor recreation and the growth of the Adirondacks as a health resort, the new idea of conservation received great impetus in this area. In 1865 Dr. Franklin B. Hough, as supervisor of the State census, took alarm at the devastation of the Adirondack forests, seeing a danger to the whole State in the denudation of the hills. His efforts to develop interest in scientific forestry under public control, aided by those of Verplanck Colvin,

a lover of the Adirondacks who discovered the source of the Hudson River on Mount Marcy, finally were successful by the year 1885.

77. In 1872 a State Park Commission was created and in the following year it submitted a report recommending a plan of forest control by the State to preserve water resources and to establish recreational areas. Surveys were conducted in the Adirondacks under Colvin's direction, but it was not until 1883 that a bill was passed withdrawing State lands in the region from sale. In 1885, New York established a forest preserve in fifteen counties of the Adirondacks and the Catskills.

78. In 1894 there was written into the New York State constitution a provision specifying that "that lands of the State, now owned or hereafter acquired, constituting the forest preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold, or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed."